Making and Unmaking the Dry City:
The Design-Politics of Flood Mitigation from Infrastructural Modernization to Climate Adaptation

by

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ABSTRACT
City leaders around the world are planning new infrastructure in response to the compound challenges of 1) flooding linked to climate change and 2) uneven urbanization. Advocates of contemporary flood mitigation efforts often frame their proposals as qualitatively different than the 'gray' levee and pump projects of previous generations. 20th century dry city infrastructural modernization projects promised to protect against flood hazards and enable urban growth, but they also had serious negative social and ecological consequences. New projects promise infrastructure that is 'green', flexible, and resilient. Building on changes in water management in the Netherlands, many recent projects around the world include a central role for designers and spatial planners. Though these new approaches have gained widespread favor, significant questions remain: Will these new flood mitigation efforts address the problems of previous generations or will they usher in more damaging mega-projects? How are the tools of design enabling and constraining transformative adaptation?

To address these questions, this study analyzes the evolving politics of flood mitigation through a transnational case study of Dhaka and New Orleans, two levee-dependent cities that are considering sweeping changes to their flood mitigation strategies. The case studies use a range of data, including: archival research on flood mitigation and planning processes; field observations of built environment conditions; and interviews with residents, experts, and participants in recent planning processes.

The study considers contemporary adaptation efforts in the context of historical flood mitigation and finds that, while emerging practices hold promise, there is reason for caution. By the end of the 20th century, both Dhaka and New Orleans had substantially similar systems of levees and pumps. The development of these dry city infrastructures was uneven, crisis-driven, and contested. Critics increasingly regarded levee-enabled growth as unwise and unjust. Though levee boosters promised that dry city infrastructures would bring modernization and orderly growth, once in place, each city's levees became embedded in broader socio-technical networks, or levee complexes, whose particular place-specific dynamics have created distinct patterns of uneven urbanization and vulnerability.

The cases of Dhaka and New Orleans suggest that contemporary projects may not deliver their promised new paradigm of flood mitigation because: existing levee complexes are highly resistant to change; path-dependent dynamics bias planning towards 'big engineering'; and even those proposals that depart from previous practices are constrained by the entrenched material interests and epistemologies that have created the unwise and unjust patterns of the past. While the inclusion of designers offers the potential for improvements in urban flood mitigation projects, there are also serious challenges. When designers are not able or willing to grapple with the place-specific political contestations that come with major planning and infrastructure interventions, their tools can be used to depoliticize these processes, ignoring, obscuring, or rushing past the distributional impacts of flood and climate adaptation.

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BDP – Bangladesh Delta Plan
BGMEA – Bangladesh Garment Manufacturers and Exporters Association
BNOBC – Bring New Orleans Back Commission
BUET – Bangladesh University of Engineering and Technology
BWDB – Bangladesh Water Development Board
CMP – Coastal Master Plan (Louisiana)
CPRA – Coastal Protection and Restoration Authority
CPZC – City Planning and Zoning Commission (New Orleans)
DAP – Detailed Area Plans (Dhaka)
DCC – Dhaka City Corporation
DIT – Dhaka Improvement Trust (precursor to RAJUK)
DMAIUDP – Dhaka Metropolitan Area Integrated Urban Development Project
DMDP – Dhaka Metropolitan Development Plan
EPWPDA – East Pakistan Water and Power Development Authority
FAP – Flood Action Plan (Bangladesh)
FEMA – Federal Emergency Management Agency (USA)
FIRM – Flood Insurance Rate Map (USA)
HMGP – Hazard Mitigation Grant Program (USA)
HSDRRS – Hurricane and Storm Damage Risk Reduction System (New Orleans)
HUD – Housing and Urban Development (USA)
IECO – International Engineering Corporation
LPVHPP – Lake Pontchartrain Hurricane Protection Program (New Orleans)
MRTP – Mississippi River and Tributaries Project (USA)
NDRC – National Disaster Resilience Competition (USA)
NEPA – National Environmental Policy Act (USA)
NFIP – National Flood Insurance Program (USA)
NORA – New Orleans Redevelopment Authority
OLB – Orleans Levee Board
PNT – Pontchartrain New Town (New Orleans)
RAJUK – Rajdhani Unnayan Kartripakkha (Dhaka Capital Development Authority)
RBD – Rebuild by Design
SELA – Southeast Louisiana Urban Flood Control Project (New Orleans)
SOWL – Save Our Wetlands (New Orleans)
SWB – Sewerage and Water Board (New Orleans)
TVA – Tennessee Valley Authority
ULI – Urban Land Institute
USACE – U.S. Army Corps of Engineers
WASA – Water and Sewer Authority (Dhaka)
WARPO – Water Resources Planning Organization (Bangladesh)
WMRT – Wallace, McHarg, Roberts and Todd (USA)

PROLOGUE

Dutch scholar Wiebe Bijker describes flood control levees as "thick with politics" (Bijker 2007b). In 1831, Goethe made the political thickness of levees the subject of his protagonist's final speech in his two volume epic drama *Faust*. As he delivers the speech, Faust is directing a massive flood protection embankment and land reclamation project to create a palatial city in what was once a seaside swamp. The passage below begins with Faust, reveling in the sounds of shovels, which he takes as heralding progress in his levee project. In reply, Mephistopheles, the devil himself, who has provided the legions of demonic laborers toiling on the project, offers an aside pointing to the hubris and futility of the project.

FAUST: The clash of spades: how it delights my heart!
These are my many workmen; here they toil,
The alienated earth to reconcile,
To keep the ocean and the land apart,
To rule the unruly waves once more.

MEPHISTOPHELES: And yet it's us you're working for
With all your foolish dams and dikes;
Neptune, the water-devil, likes
To think of the great feast there'll be
When they collapse. Do what you will, my friend,
You are all doomed! They are in league with me,
The elements, and shall destroy you in the end.

Faust celebrates levee building as sort of economic and political alchemy, transforming wasteland into a "new pleasant earth" for hardworking citizens. This ability to conjure new land, new value, and new power from the earth has made levee building an alluring proposition for state and non-state actors for millennia. Goethe's account also reveals some of the darker sides of levee building, many of which resonate with more recent critiques of flood control mega-projects, including the displacement of existing people and livelihoods for the benefit of a select few and the threat of catastrophic failure (Goethe 2008).

In Goethe's time, as in our own, reshaping the relationship between land and water invited profound philosophical and pragmatic questions. To what extent should we understand levees and land reclamation as destructive interventions in fragile ecological systems or as essential tools in expanding human prosperity? Are they rational works of engineering and design or hubristic sins against unconquerable natural forces? Are they a tool of state simplification that benefits a few powerful interests or a populist technology for expanding opportunity? Are they an essential focal point for developing democratic political institutions or are they a means for authoritarian states to demonstrate their benevolence towards a vulnerable citizenry?

This study takes the changing politics of urban flood mitigation as its focus. While Goethe's drama makes clear that levees and other infrastructures for controlling the relationship between land and water have long been the subject of debate and contestation, these issues have taken on increasing resonance in recent years as cities around the world grapple with the compound challenges of rapid urbanization in flood prone territories and increasing flood hazards linked to climate change.

CHAPTER 1
Making and Unmaking the Dry City: Introduction and Methods

All landscapes change. Climate patterns shift everywhere, soils and rock erode, and waterways migrate. In most places on earth, these landscape changes take place over centuries or millennia. In river delta regions like New Orleans' lower Mississippi delta and Dhaka's eastern Bengal delta, landscape changes occur on timescales that are readily perceivable by human beings. In a single monsoon season or hurricane season, surging waters can dramatically reorganize patterns of land and water. This dynamism undermines settled assumptions about land ownership, governance, and investment, which are fundamental to urbanization. Geographer Pierce Lewis described New Orleans as "the impossible but inevitable city"; inevitable because "the Mississippi River demands a city at its mouth," but impossible because it "fails to provide any place for one" within the "featureless slimy plain" of the delta (P. F. Lewis 2003a). Expressing a similar tension, Mughal officials who established the eastern Bengal delta colonial outpost that would become Dhaka referred to the region as "a hell full of bread," at once alluring in its fertility and strategic importance and resistant to human settlement because of the landscape's dynamism (S. U. Ahmed 1986).

This tension characterizes settlement in river delta regions around the world. They attract settlement and investment because of the military, agricultural, and commercial advantages that their position between inland waterways and maritime transportation routes provides. And yet, the unstable character of river deltas also creates serious challenges to urban settlement patterns that are premised on the solidity of the earth beneath our feet. When that solidity can no longer be taken for granted, the conventional structures of legal, spatial, and economic structures of urbanization are also upset. From the earliest years of American rule in the lower Mississippi delta to today, there have been legal conflicts over who owns the land that accretes at the edges of the winding Mississippi River (Kelman 2003). Every year, over 10,000 hectares of riverbank land is eroded in Bangladesh, displacing an estimated 130,000 people (Mollah, Bate, and Titumir 2011).

In delta regions around the world, landowners and governments have historically deployed enormous resources in the hopes of controlling flows of water and sediment to enable agricultural and urban settlement. For millennia, levees and other similar structures have been central to these efforts to tame unruly delta landscapes. In the intervening years since Goethe's 1831 epic drama *Faust* used levee-enabled land reclamation as a symbol for human striving against nature (Goethe 2008), levees have become much more widespread, enabling settlement in flood prone territories around the world. After peaking in Europe and the USA in the mid-20th century, *dry city infrastructures* of levees and pumps came under increasing criticism for creating a wide array of social and environmental problems. In the early 21st century, the paired challenges of climate change and rapid urban expansion have motivated a resurgence in large-scale flood mitigation projects, particularly in vulnerable coastal and delta regions. Many designers, planners, researchers, and policymakers celebrate this new generation of projects as embodying a new 'green' approach to infrastructure that is more flexible and resilient than the 'gray' infrastructures of the past. While this shift in infrastructural strategies has been widely embraced, many questions remain about the implications of such projects. Do they address the critiques of previous generations of levee-led growth or are they simply a rebranding of heavy-handed infrastructural modernization? How will these new infrastructures interact with or supplant existing levee infrastructure and the forms of urban development that they have enabled? Who stands to benefit and lose from this shift in infrastructural strategy?

To address these questions, this study investigates the politics of flood infrastructure, focusing particular attention on the period from the mid-20th century height of dry city infrastructural modernization to the contemporary era, with its promises of resilient green infrastructure for climate adaptation. The research investigates the historical evolutions in the relationship between urban growth and flood infrastructure through a transnational case study of two highly infrastructure dependent river delta cities, Dhaka and New Orleans.

Background and Theoretical Framework

The paired processes of climate change and uneven socio-spatial development are increasing the vulnerability of people, infrastructure, and property in cities around the world (Wilby 2007; Hallegatte et al. 2013). This increasing vulnerability is especially acute in coastal and delta cities experiencing both large-scale changes like sea level rise and increasingly severe and frequent storms and more localized processes like floodplain development and land subsidence (Hallegatte et al. 2013; Parry et al. 2007). Because of the local heterogeneity and socio-ecological complexity of climate change, the broad heading of "climate change adaptation" is used to refer to a wide range of efforts, from regional environmental governance efforts (Lebel et al. 2006) to small-scale development-linked "community based adaptation" (Ayers and Dodman 2010; Schipper et al. 2014). In many cases, states are planning and developing new structural flood protections to safeguard existing urbanized areas and to enable urban expansion (Watson 2013; Yarina 2018; Goh 2015).

While each of the subsequent chapters includes a more expansive review of relevant literatures, the sections below introduce some of the key ideas and sources that inform the research. After a brief discussion of terminology, this chapter discusses the history of levees and urbanization, along with common justifications and critiques of levee-enabled urban growth. It then describes the emergence of what has been labeled a new paradigm in 'resilient' or 'adaptive' urban flood mitigation, its relation to urban climate adaptation and its critiques. Finally, the introduction briefly reviews some of the relevant literatures on path-dependence and obduracy in the urban built environment and the role of design in shaping and expressing evolving social meaning.

Levees, Embankments, Bunds, Polders and Badhs

Before introducing the substantive material at the core of this research, it may be helpful to briefly discuss a few central terms. This study examines the changing politics of flood infrastructure over time with a focus on two case study cities, Dhaka and New Orleans. While these cities share some broad parallels in their geophysical settings and in the development of their flood protection infrastructures, they are also radically different in their urbanization contexts, and, crucially in their language, history, and culture. As Chapters Two and Three explain, both cities are substantially encompassed by linear earthen mounds designed to protect their urban settlements from inundation. While these infrastructures and their development share some striking similarities, the words used to describe them are different in each city. In New Orleans, these earthen structures are referred to as "levees," from the French for "to lift." The use of the word "levee" in the USA speaks to the legacy of the French colonists who built the first flood protection structures along the lower Mississippi in the early 18th century (Kelman 2007; P. F. Lewis 2003a; Morris 2012). It also speaks to the enduring influence of French military engineering in American flood control, an influence that is also evident in the aspirational motto of the USA's foremost flood control bureaucracy, the US Army Corps of Engineers, "Essayons," or "Let us Try" (T. A. Shallat 1994).

While the word "levee" is unquestionably the most common term used in New Orleans, in Dhaka, the question of terminology, as with many other issues in this booming and dynamic city, is more complex.

Among English-speaking officials, experts, and technocrats, the most common term used to describe the flood control structures in Dhaka, is "embankment," a term carried over from the British colonial era, when many of the delta's "river training" infrastructures were built (Iqbal 2010). While "embankment" is broadly used in technical and planning contexts, several other terms are also commonly used to describe the same structures. In some cases, people use the term "bund" to describe Dhaka's flood control embankments. "Bund," the same word used to describe a famous colonial waterfront district in Shanghai, is most commonly used to describe one particular area of Dhaka's embankments in the southwestern portion of the city, where the British colonial administration built the "Buckland Bund," a one-mile section of hardened riverfront promenade in the mid-19th century. In Dhaka, as elsewhere in South Asia, the word "ghat" refers to a stepped section of a riverbank used to access the waterfront. Among residents of many Dhaka neighborhoods, the most common term used to describe the earthen flood protection barriers is the Bengali word "badh."

In both Dhaka and New Orleans it is increasingly common to encounter terms for flood infrastructure that come from the influence of Dutch water experts. The Dutch use the word "dike" or "dyke" for earthen flood control embankments. To describe an area protected by dikes (and generally drained by pumps), the Dutch use "polder," along with associated terms such as the verbs "empolder" and "depolder."

Throughout this dissertation, I use the terms "levee" and "embankment" interchangeably and only occasionally use other terms, when the situation calls for them. Some of my central insights gained over the course of this study relate to the importance of viewing levees as part of broader infrastructural and supra-infrastructural systems and networks. To more succinctly describe the systems of levees, floodwalls, sluice gates, and mechanical drainage pumps that have been developed in both Dhaka and New Orleans over the course of the 20th century, I use the term "dry city infrastructures." I use the term "levee complexes" to describe broader socio-technical ensembles within which levees become embedded through processes of urbanization. As Chapter 4 explains, these complexes include: other non-flood related infrastructures, formal mechanisms of spatial governance and regulation; and informal or emergent social practices and expectations.

Levees and Growth

Levees have been a central tool of landscape transformation since long before the current era of rapid urbanization and climate change. Lewis Mumford identifies levees and canals as among the earliest technologies of urbanization from the ancient civilizations of the Fertile Crescent to the Low Countries of northern Europe (Mumford 1961). Levees transform the relationship between land and water, bringing relative clarity and predictability to otherwise ambiguous and dynamic landscapes and facilitating agricultural and urban development (Brammer 2000b; Mumford 1961). Because of their transformative power, hydraulic infrastructures like levees both shape and reflect shifting politics. Central authorities have used water infrastructure to assert control and shape development over broad territories, from 17th century France (Mukerji 2007) to the 20th century American West (Worster 1985) to late 20th century Vietnam (Benedikter 2014). The drive to develop ambitious hydraulic works has also been a motivating force in shaping political organization in various regions. In Wittfogel's classic account, water control infrastructures were central to the development of "hydraulic societies," as dynastic powers in east Asia mobilized massive labor forces to transform landscapes under "Oriental despotism" (Wittfogel 1959). Because they require coordinated and standardized action across time and space, structural flood controls have been associated with not only autocratic regimes, but also the emergence of democratic institutions of collective governance and decision making in the Rhine River delta and elsewhere (Bijker 2007a).

In both south Louisiana (Kidder 2000) and Bangladesh (Iqbal 2010; Brammer 2000b), the history of topographic manipulation for settlement and agriculture extends more than one thousand years. However, it was colonial frontier expansion, under the French in Louisiana (Morris 2000) and the Mughal and British in Bengal (Iqbal 2010; S. U. Ahmed 1986), that motivated the first coordinated, large-scale flood control embankments to enable plantation agriculture and settlement. From these origins as tools for colonial extraction and settlement, structural flood protections have been built using a range of justifications, including: facilitating port activity (Kelman 2000, 2003), protecting critical infrastructure, alleviating poverty (Louis Berger International 1991), facilitating urban expansion (Souther 2008), relieving traffic congestion via levee-top roads (Halcrow Group Limited 2006), providing aesthetic amenity space (Geddes 1917), and enforcing greater clarity and structure for new urban development (World Bank 2015).

The proliferation of levees in both the Bengal and Mississippi deltas was part of a broader 20th century process that Maria Kaika calls "modernity's Promethean project," promising to transform society through environmental infrastructural modernization (Kaika 2004). In both deltas, extensive levee constructions were used to discipline unruly landscapes, placing the wider regional hydrology in the service of modernization, industrialization, and urbanization (Huq and Alam 2003; Colten 2000). While city leaders had deployed limited structural flood protections for centuries, it was under the interventionist Fordist-Keynesian state-led development regimes (Gordon 1978; Harvey 1989) of the 20th century that levees became a major tool for spurring and shaping urban economic and spatial expansion. Together with mechanical drainage pumps, these 20th century urban levees constitute what I call "dry city infrastructural modernization." These infrastructural systems correspond with what Graham and Marvin call an era of "comprehensive" infrastructures, which, at least in principle, provided benefits evenly across broad territories (S. Graham and Marvin 2001). While city leaders often deployed these dry city infrastructures as a means of encouraging, modernizing, and controlling urban growth, in many cases levee boosters only overcame opposition to these aggressive interventions by rallying a sense of crisis-driven urgency in the aftermath of acute flooding events. As such, they represent an early example of what Gotham and Greenberg have identified as a pattern of "crisis urbanism" (Gotham and Greenberg 2014).

Discrediting Promethean Modernization: Levees as Unwise and Unjust

Though proponents have long celebrated the value of levees in shaping landscapes and societies, there is also a long history of critiques of these infrastructures and the settlement patterns that they enable. The most common critiques of dry city infrastructures emphasize one of two lines of criticism: 1) that levees are *unwise* in that they causes an array of serious social, ecological, and functional problems, including increasing, rather than decreasing, flood vulnerability in many cases; and 2) that levees and levee-enabled growth are *unjust,* in their uneven distribution of costs and benefits, including uneven patterns of vulnerability.

Natural hazard scholars have long criticized levees and levee-enabled growth as unwise and likely to invite calamity (White 1974; White, Kates, and Burton 2001). Because levees obscure risk, hazard researcher Shirley Laska says they "do not modify risk avoidance behavior" but rather "make it possible for behavior to remain unaltered". This "levee effect" creates an unjustified sense of security, encouraging unwise modes of development that place more people and property at risk when the levees are eventually overwhelmed (Laska 1990). The natural hazards approach, with its pragmatic critique of levees has been widely embraced by planning scholars. Natural-hazards linked planning scholars tend to advocate "non-structural" methods of flood hazard avoidance such as hazard-informed

land use regulation and building codes that reduce the exposure of people and property to floods (Burby 1998; Olshansky and Kartez 1998; Burby et al. 1999; Godschalk 2003). For hazards oriented scholars and planners, the devastation that followed the levee collapses in New Orleans during Hurricane Katrina was a clear demonstration that the levee dependent growth of the city over the previous generations had been deeply unwise (Colten, Kates, and Laska 2008).

Along with the instrumental critique that levees are unwise because they do not accomplish their stated hazard mitigation goals, these infrastructures have also long been judged unwise for causing a host of environmental problems, from habitat destruction to subsidence to channel sedimentation. The criticism of levees as unwise was already clearly evident in the mid-19th century in both the Bengal and Mississippi Deltas. An 1846 report by a committee appointed to address problems with flood embankments in colonial Bengal described levees as dangerously at odds with the natural functioning of the landscape, arguing for the removal of levees to allow "a return to the state of nature, which... ought never have been departed from" (Sage, McClelland, and Simms 1846). The path-breaking Bengali geographer, Radhakamal Mukerjee, struck a similar tone in describing the dire outcomes of flood control embankments in the Bengal delta, saying, "Famine and flood equally publish man's crime against nature and nature's stern rebuke" (Mukerjee 1938). Similarly, during the mid-19th century, opponents of the US Army Corps of Engineers' "levees only" policy for the lower Mississippi River emphasized the need to maintain natural hydrological linkages between the river and surrounding landscapes and called for a system of upstream reservoirs and designated floodway outlets (Pabis 2000; Morris 2012). An 1897 National Geographic article argued that "excluding the flood waters entirely from the great areas of the lower delta country" would lead to the "subsidence of the Gulf delta lands below the level of the sea and their gradual abandonment" (Corthell 1897).

The criticisms of levees and dry city urbanization as unjust fits with a broader critique of infrastructural modernization, which gained prominence in the late 20th century with the rise of vulnerability research and political ecology. For vulnerability researchers, hazard-shaping infrastructure such as levees are inextricably linked to the broader dynamics through which poverty, power, and politics shape the uneven distribution of hazard vulnerability (Hewitt 1983; Wisner et al. 2004). Like vulnerability research, political ecology emerged during the 1980s and 90s as scholars sought to explain the role of power and politics in shaping socio-ecological dynamics (Blaikie and Brookfield 1987). Early political ecology research focused on environmental conflict in rural and agrarian communities in developing settings (Peet and Watts 2004; Zimmerer and Bassett 2003), but more recent work has applied the same lens to a range of urban settings (Swyngedouw and Heynen 2003; N. C. Heynen, Kaika, and Swyngedouw 2006) with a substantial focus on the urban political ecology of water (Kaika 2004; Swyngedouw 1999; K. Bakker 2005). While there has been little attention to the political ecology of levees specifically (Freudenburg et al. 2008), the political ecology lens has been applied to a wide variety of hazards and forms of environmental degradation, including soil erosion (Blaikie and Brookfield 1987), wildfire (Collins 2008), and flooding (Pelling 1999). Political ecology researchers tend to analyze the dynamics through which hazard vulnerability and mitigation efforts exacerbate existing patterns of exploitation and uneven power distribution, through such mechanisms as "marginalizing" the poor into hazardous zones and "facilitating" powerful interests through targeted mitigation efforts (Collins 2008).

Political ecology researchers, along with other critics of dominant development regimes, also emphasize the role of discursive and epistemological processes in producing particular forms of problematic nature-society relations (Bridges, McCarthy, James, and Perreault 2015). Rooted firmly in post-structural and post-colonial critical theory, this research takes as the object of study, the forms and methods of knowledge production (frequently positivist, rationalist, quantitative) used to advance particular forms

of governance and economic production (frequently globalizing, capitalist, neoliberal) (Watts 2011; Ferguson 1994). Particularly relevant to this study, scholars have analyzed long-term historical projects to render complex social and ecological systems 'legible' (and therefor useable and malleable) by powerful state and non-state institutions (Scott 1998).

Because political ecology research often locates the causes of uneven environmental asset and vulnerability distribution in historical processes of exploitation and accumulation, environmental history forms an important foundation (Bridges, McCarthy, James, and Perreault 2015; Robbins 2012). There has been substantial recent scholarship on the environmental history of water and flooding in both colonial south Asia (D'Souza 2006; Iqbal 2010) and the lower Mississippi Delta (Colten 2000; Morris 2012; Kelman 2003; Campanella 2008; Barry 1997). While these environmental histories provide a crucial foundation for this study, they do not grapple with the ongoing legacy of historical levee development in shaping uneven urbanization patterns or contemporary flood mitigation efforts.

Echoing earlier criticisms of levees and other flood infrastructures as unjust, recent scholarship has raised alarms that contemporary concerns over climate-change-linked hazards may be used to justify adaptation projects with serious and problematic equity implications. Recent research highlights the tendency for infrastructure mobilization for urban climate change adaptation to deepen existing patterns of exploitation and inequality (Anguelovski et al. 2016a). Sovacool et al. offer four mechanisms through which existing inequalities might be exacerbated by climate adaptation: enclosure of public or common spaces or resources, exclusion of particular groups, encroachment on formerly protected areas or resources, and entrenchment of existing power imbalances (Sovacool, Linnér, and Goodsite 2015). Adger et al. identify equity, along with effectiveness, efficiency, and legitimacy, as four central normative criteria for assessing climate adaptation efforts (Adger, Arnell, and Tompkins 2005). Mark Pelling and others have gone further to suggest that adaptation to climate change should not only foreground equity in costs and benefits, but that adaptation should be used as a means of advancing systemic "transformation" towards greater equity, justice, and sustainability (Pelling 2010). Though they are not primarily concerned with spatial and material politics of flood infrastructure, this recent scholarship on the equity implications of climate adaptation, along with critical environmental histories, and the critical and pragmatic critiques of levee infrastructure provide crucial insights informing this study.

A New Paradigm of Urban Water Management?

The critiques of levee-enabled urbanization as *unwise* and *unjust* are part of a more sweeping criticism of the project of Promethean modernization. In light of the failures and damage wrought by previous generations' infrastructural mega-projects, scholars, practitioners, and decision makers have recently called for a wholesale reinvention of urban hazard mitigation. In the context of flood mitigation infrastructure and planning, these new approaches have used several labels, including embracing the terms "resilience" and "resilient urbanism." The sections below discuss briefly how "resilience" has been operationalized in research, policy, and design for urban flooding and climate change, how these concepts relate to the criticisms of levees, and common critiques of the resilience framing.

The concept of resilience emerged from multiple originating strains from engineering, ecology, and psychology to become influential among scholars of urban hazards and planning (Vale 2014b). From early applications by ecology researchers seeking to explain the dynamics of disturbance and change in ecological communities (Holling 1973), resilience has gained increasing prominence among researchers, philanthropies, and decision makers interested in "socio-ecological" systems including those related to urbanization and urban climate vulnerability (Lankao and Qin 2011; Fiksel 2006). In response to critiques

that natural hazards research is overly focused on individual agency and that vulnerability and political ecology research over-emphasize structural determinants of vulnerability, many resilience researchers treat vulnerability as a composite attribute that includes structural factors as well as individual and group agency (McLaughlin and Dietz 2008; K. Brown and Westaway 2011). In this view, the shift from 'vulnerability' to 'resilience' as core framing concepts has been as a shift away from a disempowering "deficits-approach" (K. Brown and Westaway 2011; Bankoff 2001). Those who embrace the concept, present resilience as more holistic, more attentive to the role of "agency and self-efficacy" (K. Brown and Westaway 2011), more open to multiple forms of knowledge, and more reflective of the idea that social-ecological systems have multiple stable states (Nelson, Adger, and Brown 2007). Resilience and the allied concept of "adaptive capacity" are frequently used in assessing the ability of individuals and social groups to adapt to the hazards associated with climate change (Tyler and Moench 2012; Smit and Wandel 2006).

Planners and designers have enthusiastically adopted the rhetoric of resilience in climate adaptation and other forms of environmental hazard. In the realm of urban flood mitigation, the shift from "hard" and "gray" flood infrastructure (e.g., levees) to "soft" "green" or "blue" infrastructure (K. Shannon 2013; Sovacool 2011) is one common manifestation of a broader embrace of "resilient urbanism." Recent movements emanating from landscape architects, architects, and urban designers like 'landscape urbanism' (Waldheim 2012) and 'ecological urbanism' (Mostafavi and Doherty 2010; Spirn 2012) share many conceptual roots with advocates of urban resilience frameworks, including the idea that human systems should be designed with flexibility and socio-ecological complexity in mind. These schools of urbanism argue for new forms and practices in the built environment that are explicitly shaped by the functioning, forces, and uncertainties of ecological systems (Mathur 2009; Mathur and Da Cunha 2001; Busquets et al. 2005). These efforts are rooted in research and writing on the ecological functioning of urban landscapes (Spirn 1985; Hough 2004), which in turn drew on the work of earlier landscape architects from Frederick Law Olmsted (Eisenman 2013) to Ian McHarg (McHarg 1969).

With the confluence of rapid urbanization and climate change-linked hazard amplification, urbanized river deltas and coastal regions have seen significant attention from researchers, designers, and planners advancing various forms of "resilient urbanism." Expertise from the Netherlands has been central to this new approach to flood mitigation and urbanization in delta regions. In the Netherlands, centuries of growth and development based on the alteration of lowland landscapes with dikes and pumps, culminating with the decades-long Deltaworks program, an aggressive planning and infrastructure effort begun following dramatic flooding in 1953 (Van Veen 1962; Wenger 2015). In the face of climate change and the mounting ecological and financial costs of flood barriers and pumps, Dutch water management authorities have begun to move from flood control via "vertical" structures like dikes and sea barriers to a "horizontal" approach to flood mitigation that relies on landscape-based strategies for accommodating, retaining, and infiltrating water (Warner 2008). In recent years, this emerging Dutch approach has been widely promoted under such labels as "delta urbanism" (Meyer 2014), "living with water," and "room for the river" (Makaske et al. 2013). Dutch consultants, practitioners, and government entities have been deeply involved in advancing these new approaches in flood prone and climate vulnerable cities around the world (Goh 2015), including in both the lower Mississippi Delta (Meyer, Morris, and Waggonner 2009)and the Bengal Delta (Bergh, Bucx, and Guchte 2012; Davies n.d.).

While the resilience framework has found favor among designers, planners, and policy-oriented scholars working on climate adaptation, it has also been critiqued as "epistemologically messy" (Gallopín 2006) and supportive of a "return to the status quo" rather than advancing "transformative change" (Pelling

2010). Some scholars claim that a focus on resilience obscures root socio-political causes of vulnerability (Cannon 2014) and facilitates the neoliberal privatization of risk (Bottrell 2009; Watts 2011). Hodson and Marvin have critiqued what they label "secure urbanism and resilient infrastructure" (SURI) as a means of "selectively privilege[ing] particular urban areas and particular social interests over others" (Hodson and Marvin 2009). They identify the production of "premium ecological enclaves" for privileged groups as a particular danger (Hodson and Marvin 2010b). These critiques suggest that, rather than addressing the problems of previous generations of flood infrastructure, resilience-framed programs and projects may be part of a larger "neoliberalization of nature" that threatens to deepen uneven vulnerability (N. Heynen and Robbins 2005).

Levees, Obduracy, and Change in Urban Space

Both positive and critical assessments of resilient infrastructure and urbanism strategies have tended to treat the transition to new infrastructural regimes as relatively straightforward processes of investment and physical restructuring. Theoretical literature from critical urban studies, science and technology studies (STS), and political ecology, suggests the need for further empirical study to understand the complex, incomplete, and variegated ways in which such social, spatial, and environmental transformations take place.

By changing hydrological regimes, levees change the site conditions for which other elements of the urban built environment are designed. Flood infrastructures also shape and are shaped by legal, political, and social conditions. As Lefebvre showed, spatial interventions and infrastructures 'produce' space in a number of ways (Lefebvre 1991). The "representations of space" as constituted in the designed spaces of engineered flood infrastructure are frequently in conflict with the "spatial practices" (perceived physical space) and the "representational spaces" (socially produced, lived space) produced once infrastructures are built and are reinterpreted and repurposed by a range of users. Castells (1977), Holston (1998), and Scott (1995), among others, have shown that the social production of urban space is a contested process in which dominant logics of spatial restructuring can be countered by various forms of resistance and insurgency (Castells 1977; Holston 1998; Scott 1998).

STS scholars describe the interactions between technological artifacts like levees and social systems as constituting "sociotechnical ensembles" in which physical objects become enmeshed in "seamless webs" with other physical and social systems (Bijker 1995). Wiebe Bijker has described levees as "thick with politics," in that they "are not only shaped by political forces," but "also exert political force themselves" through their many "connections and linkages" (Bijker 2007b). Though much of the STS literature focuses on changes in sociotechnical systems, there has been increasing attention to the inverse question of why certain systems resist change. In exploring these questions of "obduracy," or how and why systems resist change, Hommels examines the resistance of urban form to change, treating "planning as a form of technology and the city as a kind of artifact" (Hommels 2005). Describing the obduracy of urban form, Hommels says

> it is very difficult to radically alter a city's design: once in place, urban structures become fixed, obdurate, securely anchored in their own history and in the histories of the surrounding structures (Hommels 2005).

Beauregard has applied the concept of obduracy to planning theory as part of a larger project to reassert the place of "things" in planning (Beauregard 2015). The concept of obduracy in urban form also has important parallels with the concept of "path dependence" (Pierson 2000) which Sorenson elevated as an analytical concept for planning history research (Sorensen 2015). As applied to the complex sociotechnical systems of cities, both obduracy and path dependence seek to explain how early decisions and investments can constrain later choices. Chapters 2 through 4 of this study show that,

while obduracy and path dependency are useful conceptual frameworks for understanding the relationships between flood infrastructure and urbanization in Dhaka and New Orleans, the dynamics vary considerably with the specific configurations of each city's levee-centered socio-technical ensembles, or levee complexes.

Finally, from critical geography and political ecology, recent scholarship has asserted the importance of specific physical and material phenomena in shaping and resisting broader political projects. Bakker argues that studies of the "neoliberalization of nature" need to be more attentive to "uncooperative commodities" among other factors that limit and amend the extension of privatization, marketization, and enclosure (K. Bakker 2009). These literatures suggest the need to better understand how the linkages between physical and spatial phenomena and social and political networks constrain and enable attempts at restructuring environmental governance and urban space.

This study explores the place-specific patterns of path dependent urban growth that have been molded by previous generations of flood mitigation. It assesses how contemporary projects for reimagining urban flood infrastructures reckon with these uncooperative and obdurate formations. The study analyzes how the tools of design are mobilized to both shape the formation of specific obdurate urban patterns and to make the case for overcoming these patterns to restructure spatial and social relations.

Design-Politics and Flood Mitigation Infrastructure

Flood mitigation infrastructure projects can serve as powerful tools for the production and restructuring of spatial and social relations. However, the spatial and representational politics of levees and other flood infrastructure has not been the subject of systematic study. The sections below trace some of the relevant literatures defining how design and representation shape and reflect politics.

Research in the 1960s and 70s brought close attention on the social meaning in vernacular built environments (Rudofsky 1964; Rapoport 1969) and industrialized urban settings (Marcus 1971). Much of this work was only peripherally engaged with questions of politics and power. Later scholars focused particular attention on how architecture and urban design express and shape social relationships to promote commodification and consumerism (Harvey 1989; Zukin 1996) or to assert territorial power and control (Newman 1973; M. Davis 1990). More recently, Vale has analyzed how the symbolic and process politics of planned capital cities and capitol complexes reflect and contribute to nationalist projects (Vale 1992; 2014a) and how changing norms of citizenship, poverty, family, and domesticity play out in the "design-politics" of public housing redevelopment (Vale 2013). James Scott has explored how high modernist architecture and urbanism reflected the "state simplification" projects of modernizing regimes in the mid-20th century (Scott 1998), while James Holston has argued that the informal urbanization that alters such modernist environments represent a assertion of "insurgent citizenship" (Holston 1998). Though this work is not primarily concerned with environmental infrastructure, it provides interpretive strategies for treating the built environment as a terrain in which social meaning and political power are produced, deployed, and experienced.

As Lefebvre made clear, political power can be reflected in representations of space as well as in the built environment itself (Lefebvre 1991). Lisa Peattie's treatment of divergent representations and realities in the planning of Ciudad Guayana is a useful precedent for analyzing the representational politics of planning and development (Peattie 1987). Brent Ryan's method of "reading through a plan" offers insights for interpreting planning documents in the context of their time and position in the intellectual traditions of planning (Ryan 2011). The active literature on "critical cartography" also speaks to how spatial representations (in this case maps) can shape and reflect divergent knowledge and

territorial claims (Crampton and Krygier 2005; Harley 1989; Pickles 2003). Writers on critical cartography analyze how map making can be a tool for consciously or unconsciously shaping political power, both by powerful institutions and through "counter mapping" to present underappreciated viewpoints (Kim 2015; Solnit and Dawson 2010; Solnit and Jelly-Schapiro 2016; Solnit and Snedeker 2013).

The symbolic and process politics of infrastructure and its design representations are generally not central to urban political ecology or other critical infrastructure research. Recent work by Matthew Gandy and Maria Kaika are exceptions. Gandy's account of the 19th century sewers of Paris and the photographs thereof analyzes how changes in infrastructure systems and their representations marked a significant shift in urban society-nature relations (Gandy 1999b). Kaika's analysis of the dams and other water infrastructure in Athens and London makes the case that classical architectural cladding was paired with "Promethean" technological infrastructure to elevated the social stature of the infrastructure and link it to celebrated histories (Kaika 2006, 2004). Much as Gandy and Kaika use the aesthetic politics of sewers and dams as lenses through which to view changing attitudes towards constructed natures, domesticity, privacy, and hygiene, this study analyzes the evolving design-politics of urban flood protection as a means of understanding shifts in societal attitudes towards growth, risk, and nature.

Research Questions, Design, and Methods

This research is guided by four linked questions:

- How has the relationship between flood mitigation infrastructure and urban growth changed from the mid 20th century to the contemporary era?
- How have levees shaped urban space and life differently in Dhaka and New Orleans?
- To what extent do recent flood mitigation projects represent a "new paradigm" likely to address the problematic outcomes of previous generations of flood control infrastructure?
- How has the increased role of design and spatial planning methods enabled and constrained these changes?

Paired Transnational Case Study Structure

This study centers on transnational case studies in two levee-dependent cities currently contemplating major green infrastructure plans, New Orleans and Dhaka. By studying Dhaka and New Orleans side-by-side, the project offers the chance to glean insights into the complex pathways through which flood protection infrastructures become embedded in the social and physical environment of cities. The focus on Dhaka and New Orleans also offers an opportunity to observe how the relational dynamics of knowledge and policy transfer have shaped urban flood control practices historically and in the contemporary era.

Robinson has urged comparative urban research across differences that would once have been presumed to be incommensurable, especially across the "global North-South divide" and "across contexts of wealthier and poorer cities" (Robinson 2011). She draws on Pickvance's advocacy for "variation-finding" and discovery of "plural causalities" through comparisons of "most similar" and "most different" cases (Pickvance 1986). The distinct points of convergence and departure of flood mitigation in Dhaka and New Orleans provided a means of seeing each city more clearly and analyzing linkages between them.

In Roy's framing, "transnational examinations can use one site to pose questions of another" in order to decenter and destabilize entrenched modes of inquiry and reveal new potentials for research and action (Ananya Roy 2003). In this study, transnational inquiry invites novel questions for a first world city like

New Orleans, such as: What emergent and informal responses can be discerned in the built environment surrounding levees? What are the alternate forms of environmental knowledge at play in shaping hazard exposure and how do they come into contact and tension with dominant scientific rationality? Similarly, by placing Dhaka next to New Orleans, the stark differences in the two cities' growth patterns reveal the problematic nature of unspoken assumptions embedded in the mid-20th century "Western" or "Northern" models of dry city infrastructural modernization.

Bakker has also urged comparative research as a means of lending greater rigor to studies on the "neoliberalization of nature" (K. Bakker 2009). She argues that too often political ecology research focuses on single case studies and misses opportunities to build more nuanced models and more complex understandings of socio-natures. By considering New Orleans and Dhaka with respect to one another, this study brings greater clarity to commonalities and points of divergence in shifting flood mitigation strategies that have shaped these cities, including the "splintering" of collective flood infrastructures in the late 20th century (S. Graham and Marvin 2001).

Case Selection

Dhaka and New Orleans share important similarities in their climate hazard exposure and in the historical development of their flood infrastructures. Both cities are situated near the mouth of great continental river systems and face significant and growing flooding threats from multiple sources. To cope with these threats, both cities developed dry city infrastructures of levees and pumps culminating in major levee projects during the late 20th century.

The similarities in Dhaka and New Orleans' dry city infrastructures are especially notable given the stark differences between the cities. Dhaka and New Orleans are radically different in terms of their demographic trajectories, socio-economic conditions, and recent political history. New Orleans is a relatively small and, until recently, shrinking city in a nation of immense wealth and power while Dhaka is a booming capital of one of the world's "least developed countries." While the USA has enjoyed relative political stability and growth for over two centuries, the territory that is now Bangladesh has been wracked by political division and instability since it emerged from British colonial rule in 1947. This instability has continued over the last forty-five years since Bangladesh became an independent nation. Since the middle of the 20th century, the USA has been active in promoting a particular vision of governance and development around the world through military, diplomatic, and technical means, while Bangladesh has been one of the biggest recipients of foreign aid, introducing a range of outside perspectives and technical expertise.

While the dry city infrastructures in each city are similar, the temporal and spatial relationship between those infrastructures and broader urbanization processes differ significantly. While New Orleans has been utterly reliant on structural flood protections since the city's founding in the early 18th century, Dhaka long relied on other methods of flood mitigation, only building encompassing levees and pumps in the late 20th century after nearly four hundred years of urbanization. In each city, the levee infrastructure put in place over the 20th century has become embedded in dense socio-technical ensembles, shaping the urban form and built environment in surrounding areas in very different ways. In New Orleans, the city's levees have largely acted as edges delineating distinctly different patterns of urbanization whereas in Dhaka, the levees have become spines of urbanization, enabling the spread of urban settlements both inside and outside the intended zones of protection.

In spite of the radically different ways that dry city infrastructures have shaped urban form and the built environment in these two settings, both cities are now exploring similar alternative infrastructure

strategies to protect against increasing climate change-related flooding. Contemporary efforts in both cities are deeply shaped by the new global preferences for Dutch-influenced, "horizontal" landscape-based green infrastructure strategies, emphasizing flexibility and sensitivity to socio-ecological context. While these new approaches hold considerable promise, their application in settings as radically different as New Orleans and Dhaka raises significant questions.

Linkages and Relations between Sites

In addition to inviting new questions and modes of inquiry, this transnational case study research design offers opportunities to consider the institutional and intellectual linkages that have shaped the politics of flood protection in these two settings. A relational reading of sites invites researchers to consider places as interconnected through networks of policy, advocacy, and activism (Ananya Roy 2003). In the case of flood mitigation infrastructure in Dhaka and New Orleans, these connections include a shared heritage of European colonial administration, asymmetric but shared involvement in 'delta city' and climate adaptation networks, and decades of U.S. involvement in water infrastructure development in Bangladesh.

The U.S. has been deeply involved in providing both financial and technical support for flood protections in Dhaka and Bangladesh for more than fifty years. Early efforts during the East Pakistan-era included water infrastructural modernization plans carried out by a coalition of private contractors, public hydraulic bureaucracies or "hydrocracies" (Molle, Mollinga, and Wester 2009) like the USACE and the TVA, and newly formed international aid organizations like the UN and World Bank (United Nations Water Control Mission 1959; EPWAPDA and IECO 1964). Collectively, these groups were identified in a 1954 *Time* magazine feature as "Ambassadors with Bulldozers." Later, U.S.-based experts were involved in both promoting and critiquing the ambitious Flood Action Plan (FAP), whose outcomes included Dhaka's first encompassing embankments (Boyce 1990; Thompson and Sultana 2000; Rogers, Lydon, and Seckler 1989; Brammer 2000a). U.S. involvement in Dhaka's flood infrastructure planning continues through ongoing World Bank-funded studies of embanking the eastern portion of the city (World Bank 2015).

In addition to the direct U.S. interventions in Dhaka's flood planning, there are other important indirect relational connections in the contemporary efforts of experts from the Netherlands to export the Dutch model of water management to both Dhaka and New Orleans, and to other flood-vulnerable cities worldwide (Zaken 2014; Bergh, Bucx, and Guchte 2012; Goh 2015). While Dutch water policy was largely in line with the hard infrastructure-reliant approaches used in New Orleans and Dhaka in the mid to late 20th century (Van Veen 1962), by 2010 the Dutch government's approach had substantially shifted to de-emphasize hard infrastructure through the 2007 *Room for the River Plan* and the 2010 *New Deltaplan*. As part of an international effort to expand the reach of the Dutch water sector, Dutch water experts, planners, and designers have been integrally involved in reformulating the approach to water management in both New Orleans and Dhaka. The representations and rhetoric surrounding this new model of flexible, resilient, and ecologically sensitive infrastructure depart significantly from previous generations of levee design-politics. The spatial and political implications of the interaction between these new infrastructures and existing conventional engineered infrastructure and levee-dependent models of urban growth are a core focus of this study.

Data Sources and Analysis

To situate contemporary projects in the context of a longer trajectory of flood mitigation politics, this study draws on a range of data sources and methods of analysis. The political content and impacts of urban planning, design, and infrastructures are complex, dynamic, and deeply context-dependent. As

such, discerning evolving social meaning from built and proposed infrastructures requires triangulation between different sources and types of data. The study includes data gathered from direct observation and analysis of the built environment, graphic representations and text sources related to planning and infrastructure development, and interviews with actors across a range of perspectives.

Built Environment

The built environments of cities can be seen as composites of meaning-laden artifacts to be closely observed and analyzed in conjunction with other sources of data. The material and spatial configurations of the built environment not only express the values of previous generations, but also shape the decisions of future generations through creating sociotechnical ensembles with unique forms of obduracy or resistance to change (Hommels 2005; Beauregard 2015). Dhaka and New Orleans' existing flood protection infrastructures and the urban environments in which they are embedded were a vital starting point for understanding the accumulated decisions and investments that have shaped these landscapes. Photographs, field sketches, and original maps were essential methods for documenting and analyzing the existing conditions in the built environments.

I conducted extensive observations during multiple field visits in both cities beginning in January 2014 and ending in August 2017. Field observations included consideration of: material and spatial conditions of levees themselves; the presence of sanctioned or unsanctioned interventions on or near levees; how levees and their landscapes resemble and differ from official plans and design representations; spatial relationships between levees and surrounding built environments; the degree of differentiation between the spatial patterns on one side and the other of levees; and corridor functions and other secondary uses of levees.

Text Documents and Visual Representations

In conjunction with analysis of the built environment, the study included consideration of a range of written documents and visual representations. Through reviews of gray literature, archival materials, and contemporary planning documents, I analyzed the evolution of rhetoric justifying and contesting flood mitigation infrastructure projects. The historical analysis drew on several sources, including: flooding and drainage infrastructure planning and study documents; land use and master planning reports; archived correspondences from government officials and other actors involved in infrastructure development and debates; annual reports and other public-facing documents produced by relevant government agencies; and a range of other archived materials. Published accounts by historical actors and archived local media (e.g., newspapers) were valuable references for understanding the evolving contexts for planning processes, infrastructure decision making, public opinion, and controversies related to levee projects. I visited archives in Louisiana, Bangladesh, India, the UK, and the Netherlands. A complete list of archives visited for the collection of historical documents is included as Appendix 2.

Through archival material as well as secondary literature, I constructed timelines for Dhaka and New Orleans to track the chronological development of urbanization, flood infrastructure development, urban planning, flooding events, and broader political change. This parallel reading revealed the relationship between flood infrastructure planning, urban planning more generally, and other critical dynamics in the cities. Analysis of text and visual materials across sources and types of documents relied on qualitative coding using MaxQDA. Codes tracked the patterns and evolution of rhetoric and representations related to spatial planning and flood infrastructure from the era of 20th century dry city infrastructural modernization through the contemporary era of climate resilient adaptation proposals.

Interviews

While the historical portion of this project necessarily relied heavily on archived documents and press accounts, interviews were a central component of understanding recent and ongoing projects, events, and conditions in both Dhaka and New Orleans. The interviews were split between two primary groups of people: 1) expert participants and observers of planning and infrastructure design projects and 2) residents of levee-impacted areas of Dhaka and New Orleans.

Expert interviews were semi-structured and tailored to the particular expertise and experience of the subjects. Expert interviews gathered factual data on flood mitigation and planning projects and gleaned insights into the interview subjects' perceptions on a range of issues, including: how dominant flood mitigation strategies are and are not changing; perceptions of power relations between different institutional and professional constituencies within planning processes; and the value and limitations of the tools and methods of design and spatial planning in these processes. In both Dhaka and New Orleans, I interviewed a range of experts. The 88 expert interviews were split between several groups, including: civil society and international aid institutions; academic experts; government officials; and designers, planners, and other technical consultants. Expert interviews were conducted in English. These interviews were conducted in a range of locations at the choosing and convenience of the interview subjects. The majority of interviews were conducted in the offices of the experts in Dhaka, New Orleans, and the Netherlands. Interviews ranged in duration from 15 minutes to 120 minutes. Key informants in each city were interviewed on multiple occasions to corroborate and triangulate insights gathered from other sources. A list of expert interviews is included as Appendix 1. In addition to these one-on-one interviews, I also attended a public meeting associated with the release of the 2017 Louisiana Coastal Master Plan in New Orleans. Observing this meeting was useful in illuminating some of the political contestations surrounding that ongoing process and enabling me to meet several officials and experts who were in attendance.

Over the course of several field visits, I interviewed 75 residents spread across a range of neighborhoods near Dhaka and New Orleans' primary flood protection levees. Interviews with residents in infrastructure-impacted areas provided critical insights into how they perceive of flood risk, government efforts to mitigate flood risk, and how they make decisions about where to live and how to build. Interviews with residents were semi-structured according to interview guides to ensure a basic level of thoroughness and comparability, while allowing for flexibility and discovery. Resident interviews ranged in length from 20 to 90 minutes and were primarily conducted in and around the homes of residents. Conducting the interviews in residents' homes allowed me to directly observe and ask questions related to elements of the built environment, including attempts to adapt to flood risks. In Dhaka, resident interviews were conducted with the assistance of Bangla-speaking research assistants and translators. In the initial research design, extensive and systematic resident interviews were a central part of the project. The number and centrality of the resident interviews was ultimately reduced because of increased security concerns in Dhaka beginning in 2015. Nonetheless, the field notes and transcripts of interviews served as crucial data for analyzing how levee infrastructure has shaped conditions and decision making for residents. It was especially valuable to compare the expectations of flood mitigation planners as expressed in planning documents to the reports and lived experience of people on the ground in each city.

When possible, interviews were digitally recorded, transcribed and coded for analysis using MaxQDA qualitative coding software. When recording was not possible due to the preference of subjects or other

constraints, I took extensive field notes during the interviews and later coded those notes for the purposes of analysis and triangulation with other data sources.

Dissertation Structure and Themes

The dissertation is composed of three substantive components: Part One on the history and evolutions of flood mitigation infrastructures in New Orleans and Dhaka; Part Two on the emergence of distinct levee-related urbanization patterns and; Part Three on the recent and ongoing efforts promising a new paradigm of flood mitigation. Part One is composed of Chapters Two and Three. Following this introductory chapter, Chapter Two and Three recount the emergence, evolutions, and mounting critiques of dry city infrastructure approaches in New Orleans and Dhaka respectively. These chapters are based primarily on archival research tracking the progression of infrastructure development and urban planning in each city. The process of developing each city's 20th century dry city infrastructures was contested, episodic, crisis-driven, and uneven. Promising that levees, accessory infrastructures, and spatial governance reforms would modernize and order urban growth, levee boosters in both cities overcame objections and alternative models of flood mitigation by capitalizing on post-flood crisis "policy windows" to advance their projects (Kingdon 1984). By the end of the 20th century, both cities had developed substantially similar systems of encompassing flood protection embankments coupled with mechanical drainage pumps. The parallel development of flood infrastructure development in the Mississippi and Bengal deltas over the latter half of the 20th century is partially a product of the aggressive international expansion of a particular vision of water infrastructural modernization by US-based "Ambassadors with Bulldozers" coalitions. By the end of the 20th century, dry city infrastructures in both cities came under increasing criticism as unwise and unjust.

In Part Two, Chapter Four analyzes how levees in Dhaka and New Orleans have shaped and been shaped by urbanization. It finds that, while levee boosters made bold promises about the capacity of dry city infrastructures to control and enable modern urban development, in both cities, growth patterns largely did not match those promises. 20th century levee planners' assumptions were based on universalized concepts of rational planning, scientific engineering, and functional spatial governance. The actual patterns of urbanization that have taken shape in Dhaka and New Orleans following their levee constructions have been highly place-specific, historically-contingent, and path-dependent. Levees in each city have become enmeshed in complex and dynamic socio-technical ensembles, which include intertwined engineered systems, spatial governance regimes, and emergent social patterns. The composition and dynamics of these levee complexes, more than the designed form of the infrastructures themselves, have shaped urbanization patterns.

Part Three of the dissertation examines the design-politics of evolving flood mitigation practices in Dhaka and New Orleans today. Chapter Five explores recent and ongoing flood mitigation planning projects in Dhaka and New Orleans. It considers if these projects represent a new paradigm of urban water management as promised by project boosters in each city and in the Netherlands. Through analysis of planning documents and interviews, the chapter assesses if this new generation of mega-projects addresses the critiques of previous generations or if they reproduce the problematic patterns of the past. Dutch water management experts, including prominent design and planning practitioners, have been deeply involved in projects in both Dhaka and New Orleans, promoting projects promising more flexibility and more holistic integration with place-specific socio-technical networks. These projects embrace the rhetoric of landscape and context-sensitivity. They often promise a reduction in engineered control, using such labels as "living with water" and "room for the river." The chapter finds that these projects have, thus far, largely under-delivered on the promise of revolutionizing water management. Rather, it finds that existing infrastructures and the urbanization patterns that they have enabled are

highly obdurate due to both physical and political processes. It further finds that many of the projects that are emerging from ambitious multi-disciplinary Dutch-influenced water planning projects are thinly rebranded dry city infrastructure projects. Even in those projects that do depart in significant ways from the 20th century dry city model, the persistence of abstracting epistemologies and entrenched material interests have supported the continuation of what one project participant called a "big engineering" approach.

Chapter Six focuses on the increasing role of visualization and other tools and methods from design and spatial planning in recent urban flood mitigation projects. It asks how these tools may improve these projects and considers challenges and dangers. The chapter reports broad agreement among many project participants and observers that the tools of design are improving the deliberative processes, multi-benefit project designs, and public communications of these projects. However, I also find that there are some serious limitations and concerns regarding the increased role of design in ambitious water planning projects. With the increasing internationalization of these processes, designers are frequently positioned as critical "connectors" between disciplines and translators between the universalizing epistemologies of technical infrastructure design and the particular place-specific dynamics of cities. The cases in Dhaka and New Orleans suggest that the capacity of designers to act in this synthetic and catalytic role is dependent on the receptivity of other project players, which varies with both professional and international cultural differences. These cases also suggest that designers are often unwilling or unable to grapple with the place-specific socio-political contestations that will come with major water infrastructure projects. In many cases, persuasive design visualizations communicate proposals in ways that ignore, minimize, or obscure areas of political contestation and debate. Among the key depoliticizing mechanisms of recent design-centered projects are: invocation of "apocalyptic imaginaries" (Swyngedouw 2010) and crisis driven-urgency; foregrounding of purportedly neutral geophysical landscape variables; calls to restore settlement patterns of an imagined harmonious past; and promises of "win-win" solutions with no distributional or equity implications.

Chapter Seven revisits the key findings and arguments from the previous chapters and presents recommendations for how these findings might inform research, policy, and practice related to urban flood mitigation and climate adaptation more generally.

Research Contributions

This dissertation contributes to evolving debates in theory, methods, and practice in several ways.

Theoretical Contributions

This research engages theoretical literatures from planning, landscape architecture, critical development studies, natural hazards, vulnerability, political ecology, and climate adaptation. Among the key theoretical interventions of the project are:

Giving Urban Climate Adaptation a History

In scholarship, planning, and policy-making, climate change and the need to adapt to its hazards are often treated as unprecedented challenges. Naomi Klein tells us that climate change "changes everything" (Klein 2014). Historians like Dipesh Chakrabarty have embraced the term "Anthropocene" to label the geological and historical rupture of our human-dominated era (Chakrabarty 2009). This sense of unprecedented crisis is increasingly being used to justify major projects to restructure urban environments. Even as the threats of climate change and the demands of adaptation challenge our capacity to draw on historical precedents to understand and adjust, this dissertation makes clear that

urban climate adaptation must be seen in light of the linked physical and political history of urbanization as it has unfolded in particular places.

Just as Andreas Malm argues for an historical perspective on climate change by explaining that "global warming is a result of actions in the past," this dissertation makes the case for an historical perspective on adaptation because the vulnerability of people and property are fundamentally a result of past urbanization actions (Malm 2017). In every city, the history of urbanization is a history of mobilizing political power, wealth, and material to transform landscape dynamics. Past environmental transformation, both planned intervention and emergent responses, directly shape the physical and political possibilities for contemporary cities as they balance the need to adapt to climate vulnerability with other competing interests. While the urban political ecology literature takes seriously the historical roots of contemporary uneven development and vulnerability, it often does not substantially engage with questions of how the built environment is formed. Conversely, much of the climate adaptation literature from landscape architecture, urban design, and planning does not substantially engage with the historical processes of uneven development. This study lays out some key markers in this relatively unexplored territory.

The Politics of Design for Climate Adaptation

This research suggests that the politics of design and representation for flood mitigation and climate adaptation is an area in need of serious theoretical and pragmatic inquiry (Figure 1.1). The project's central conceptual triad is composed of: 1) politics and power in urban environments, 2) design and space, and 3) flood hazard mitigation and climate adaptation. Each of these three legs has its own substantial literatures. Considered as dyads, each pair composed of the constituent elements has also been the subject of substantial inquiry.

Design and Politics: From Lefebvre onward there has been decades of theoretical work exploring how the lived experience and representations of urban built environments both shape and express political meaning through material and space. Vale uses the term "design-politics" to describe this nexus (Vale 2013).

Design and Adaptation: From Olmsted and McHarg to contemporary advocates of landscape urbanism and ecological urbanism, designers and spatial planners have long been engaged in pragmatic and theoretical deliberations related to flood hazard mitigation, and more recently climate adaptation.

Adaptation and Politics: Scholarship from political ecology and vulnerability researchers has long made the case that uneven flood risk, like other uneven vulnerabilities is deeply tied to broader socio-economic inequalities. They have also made clear that these uneven hazardscapes are tied to particular modes of environmental knowledge production and representation. Recent work from planning and adjacent fields has traced the politics of uneven climate adaptation.

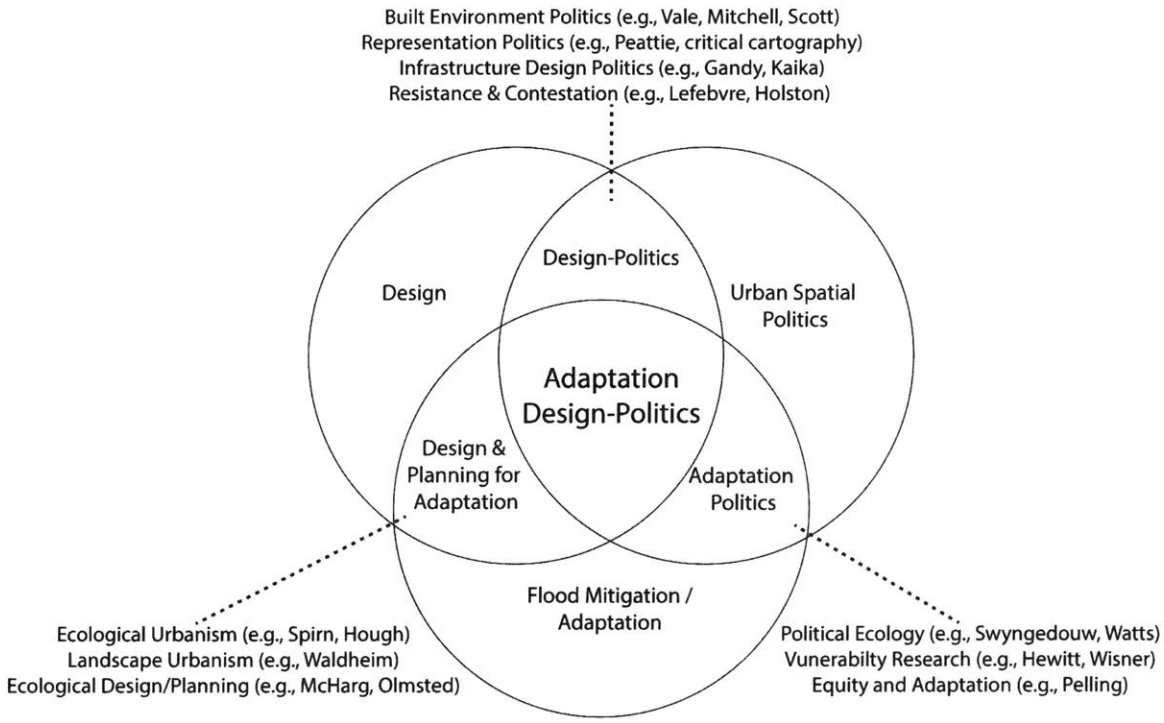


Figure 1.2. Adaptation design-politics.

Adaptation Design-Politics: As yet, there has been little theoretical inquiry into the design-politics of adaptation and flood mitigation. This is the theoretical convergence at the heart of this study: explaining how the representation and manipulation of urban spatial and material environments by designers and planners contribute to adaptation processes that can both advance transformative change and constrain debate, reinforcing existing socio-economic disparities.

Methodological Contributions

The project's theoretical contributions are grounded in its empirical inquiry. The study's methodological contributions come from the attempts to bridge between disparate empirical realms and forms of inquiry.

Historical and Future Orientations

The study historicizes urban climate adaptation and contemporary flood mitigation efforts by tracing path-dependent patterns of urbanization and prior infrastructure development. By including consideration of both historical processes and contemporary and forward-looking planning and design projects, the project identifies realms in which the politics of urban flooding have changed over time and where they have stayed the same. This pairing of historical and contemporary analysis also enables the study to identify place-specific, path-dependent dynamics that influence areas of future adaptation opportunity and resistance. This pairing of research on historical and contemporary urbanizing processes could inform many realms of urban research in which existing physical and political conditions comes into conflict with the drive for urban restructuring and 'creative destruction.' The historicizing perspective is especially critical in the context of crisis-driven planning and design interventions, which are often presented as exceptional and largely ahistorical.

Relational Reading of Cities

The study contributes to the growing interest in transnational urban research across North-South and rich-poor divides. "Seeing" New Orleans from Dhaka and Dhaka from New Orleans, enabled the study to ask unorthodox questions of each city and to interrogate the direct and indirect linkages that have influenced the development of their flood infrastructures. Viewing these cities together enables the study to investigate how previous generations of flood infrastructure have shaped urbanization patterns in radically different ways in these very different contexts. These cases demonstrate a long history of policy mobility with respect to water infrastructure and planning. This internationalization of expertise is increasing, particularly with respect to climate adaptation. As such, there is a need for more research investigating how shifting international 'best practices' are and are not adapted to the physical and political conditions of cities around the world that may share some geophysical characteristics but are otherwise quite different.

Planned and Emergent Urbanization Processes

The study includes investigations of both planned and emergent urbanization processes related to flood infrastructure in Dhaka and New Orleans. In Lefebvre's terms, it considers "representations of space" as conceived in plans and designs as well as "spatial practice" (real or physical space) and "representational space" or socially produced space (Lefebvre 1991). This approach required a sometimes-schizophrenic oscillation between the worlds of abstract technical expertise and the complexities and dynamism of the city as lived. By considering both planned and emergent urbanization impacts of levees and other flood infrastructures, the study identifies problematic planning and design simplifications and assumptions as well as overlooked drivers of urban change. As cities around the world begin to consider major changes in their infrastructure and settlement patterns in the name of climate adaptation, it will be essential to take stock of the ways in which historical urbanization has followed and departed from the projections of past project plans and designs.

Urban Design-Politics

The research contributes to the development of interpretive mixed-methods for analyzing urban design-politics through visual, verbal, and textual rhetoric. Bridging between past and future, between North and South, and between planned and emergent urbanization patterns required methodological promiscuity, bringing together analysis of the built environment, texts and visual representations from planning and policy documents, and interviews. This study triangulates between these sources and methods to discern and elaborate upon the social and political meaning of infrastructure design. Of particular importance in this study is the treatment of visual representations from planning, engineering, and design. Reading design visualizations in parallel with insights from interviews, texts sources, and direct observations of the built environment enables the study to consider how the use of visualization has changed over time and how the increasingly prominent role of the design professions in flood infrastructure planning might enable and constrain future planning efforts.

Toward Equitable Climate Adaptation Planning and Design

This study contributes to pressing contemporary debates regarding planning and policy pathways for equitable flood mitigation and climate adaptation. It interrogates the extent to which emerging strategies focused on 'flexible' and 'resilient' climate adaptation represent a decisive shift from the flood mitigation efforts of the past and how these new projects will relate to existing infrastructures and levee-dependent urban patterns. In the process, the dissertation opens new pathways for interrogating the role of design and planning in complex socio-ecological urban infrastructure projects. Designers and planners have been eager to contribute to these critical contemporary urban challenges. However, it remains far from certain whether these projects will bring transformative adaptation that addresses the

deeper causes of uneven vulnerability or if they will superficially rebrand conventional mega-project approaches and reproduce their unwise and unjust outcomes. For designers and planners to contribute to transformative adaptation, they will need to develop new theoretical and methodological capacities to: respect, solicit, and assimilate a broader range of perspectives and forms of knowledge; reckon with historically embedded spatial politics; recognize their own political agency; and mobilize their tools of synthesis and persuasion towards greater pluralism and equity in adaptation. This study is intended to provide some analytical grounding for these critically important efforts.

PART I
The Rise and Fall of Dry City Infrastructural Modernization in Dhaka and New Orleans

The founding of Dhaka and New Orleans were separated by roughly one hundred years and 9,000 miles. Today, the booming capital of Bangladesh and the sleepy Southern city near the mouth of the Mississippi appear to have little in common beyond spicy rice-heavy cuisine and climates marked by heat, humidity, and occasional torrential downpours. And yet, over the more four centuries since Mughal officials constructed their colonial outpost at Jahangir on the banks of the Buriganga River in 1608 and the three centuries since Jean-Baptiste Le Moyne, Sieur de Bienville landed on the site between the Mississippi River and Lake Pontchartrain in 1718, the two cities have shared a history of growth and change largely defined by their relationship to their watery deltaic landscapes. Though Dhaka and New Orleans are radically different in their demographics, governance, and economics, in both cases, their form and character are largely a function of a struggle to maintain stable urban settlements in a landscape that is fundamentally hostile to constancy. The cities are connected by their shared flood hazards. They are also linked by commonalities in the ideologies and technologies of their evolving urban water management strategies. In both cities, leaders have developed intertwined technological and administrative methods to shape urbanization and to alter the underlying delta landscape to protect existing settlements and enable expansion.

The following two chapters introduce the case study cities, briefly recounting the historical development of urbanization and flood infrastructures in Dhaka and New Orleans. The chapters trace the rise and fall of dry city infrastructural modernization, a process through which administrative and bureaucratic innovations across multiple scales of government, harnessed scientific knowledge and engineering to transform each city's geophysical, social, and economic landscapes.

Though the case introductions begin in the earliest days of each city, they focus particular attention on the 20th century. This is the period when the relationship between urbanization and water management underwent the most striking changes in both Dhaka and New Orleans. These changes were driven by technological and institutional shifts in two frequently disconnected sectors: (1) civil engineering for controlling water and (2) spatial governance and urban planning. In New Orleans, these parallel developments in engineering and planning came with the confluence of a growing Federal commitment to a Fordist-Keynesian policy of "internal improvements" (T. A. Shallat 1994) and powerful and well-coordinated "growth coalitions" of local public and private actors (Logan and Molotch 1987) who saw land reclamation, through levees, pumps, canals, and pipes as a primary tool of modernization, economic growth, and intercity competition. Filion describes this linkage between state planning and infrastructure development and private growth saying,

> In a climate where the complementarity between the public and private sectors was a matter of general acceptance, governments were expected to engage in ambitious infrastructure programs and use their coordination capacity to provide a built environment suited to fordist production and consumption. (Filion 1999)

While the model of levee-led urban growth and infrastructural modernization only took hold in Dhaka several decades after it did in New Orleans, by the end of the 20th century, Dhaka too was reliant on a system of earthen embankments and mechanical pumps to keep urban territory free of river and rain flooding. The development of infrastructural modernization and urban planning in Dhaka and the eastern Bengal delta more generally was shaped substantially by links to institutions, technologies, and practices that emerged in the USA in the early and mid-20th century. In the decades after the end of British colonial rule in 1947, Federal water engineering bureaucracies and private sector engineering and

construction firms from the USA exerted significant influence on the emerging institutions and technics of water infrastructural modernization in East Pakistan, the territory that would become Bangladesh.

Though levee and pump-based dry city infrastructural modernization became the dominant mode of urban water management in Dhaka and New Orleans over the 20th century, in both cities, the emergence and evolution of this model was uneven, non-linear, crisis driven, and contested. At various points over the 20th century rise of dry city infrastructural modernization in Dhaka and New Orleans, critics resisted these aggressive interventions and advanced alternative visions for urban water management. Levee boosters were often only able to overcome these criticisms and alternatives by capitalizing on crisis-driven urgency after major flooding events.

Infrastructural modernization through flood control promised safety, prosperity, and socio-spatial modernization. However, by the later decades of the 20th century, critics in both the US and Bangladesh were mounting ever greater resistance to such projects. They argued against flood control projects on the grounds that they were *unwise* in that they caused major unintended social and environmental damages, often creating more rather than less flood vulnerability by enabling unsafe development patterns in newly protected zones. Others argued that such heavy-handed, top-down interventions were too often *unjust,* in that they created benefits for a small number of well-connected pro-development interests at the expense of less powerful constituents who were harmed through displacement, disruption of existing hydrological patterns, and other mechanisms. These critiques, along with broader neoliberal state retrenchment, led to a reduction in state-led collective flood protection as part of what geographer Maria Kaika calls the "discrediting" of Promethean modernization (Kaika 2004) and Gandy calls the "demise of technological modernism" (Gandy 2002). As infrastructure budgets shrank and resistance to muscular interventions grew, urbanization in both Dhaka and New Orleans has become less tightly coupled to state-sponsored flood control projects in recent decades.

The following two chapters trace the emergence of dry city infrastructural modernization in Dhaka and New Orleans. They recount the spatially uneven, episodic, and contested processes by which these models of urban growth and water management gained dominance. And finally, they recount the increasingly prominent and powerful criticism of this model in both cities.

Levees and Urbanization in Dhaka and New Orleans

Recent dramatic flooding events in cities from New Orleans to New York to Houston have raised the profile of urban water issues among scholars in a broad range of fields. While both Dhaka and New Orleans have been substantially shaped by their relationships to water, scholarly accounts of these historical relationships are uneven and incomplete.

The historical development of New Orleans' flood control and drainage infrastructure has been skillfully and deeply described by several historical geographers, with heightened interest in the years since Hurricane Katrina (Colten 2005; Morris 2012; Kelman 2003; Colten 2000; Campanella 2008; Powell 2012). The relationship between planning history and water management in New Orleans has received far less scholarly attention than the historical changes in pipes, pumps, and levees. Though there has been tremendous scholarly interest in the unfolding of the city's post-Katrina planning processes (e.g., Olshansky et al. 2010), the role of earlier planning efforts in shaping New Orleans' uneven vulnerability has not been systematically analyzed. Planning historians and theorists have recounted the linkages between New Orleans' planning institutions, projects, and processes and the city's commercial elites in the early (Brownell 1975) and mid-20th century (Fainstein 1983), but this work has tended to treat water management only peripherally. More recently, scholars have considered the linkages between flood

control, drainage, and planning in the mid to late 20th century suburban development of New Orleans East (Baxter 2014; Souther 2008), but this work does not generally relate these processes to the earlier emergence of infrastructural modernization in the city.

While the history of infrastructural interventions in the Bengal Delta has received scholarly attention in recent years (Iqbal 2010; Da Cunha forthcoming), this work tends to focus on larger landscape and delta scale interventions and treats urban areas only peripherally. Meanwhile, canonical histories of Dhaka treat environmental change and flood and drainage infrastructure only tangentially (S. U. Ahmed 1986; Dani 1962). Because Dhaka has seen enormous growth, both spatially and demographically, in recent years, most of the city's flood and drainage infrastructure interventions have taken place in recent decades. The literature on Dhaka's urbanization and development treats flooding, landfilling, and infrastructure change as one among many factors in the city's rapid change (Islam and Shafi 2010; A. M. Chowdhury and Hasan 2011). Research on the history of Dhaka's planning institutions and plans tends to be quite descriptive and is not well connected to the history of the city's flood control and drainage infrastructure (Jahan 2011). Much of the literature that engages with questions of how Dhaka's flood infrastructure has shaped urban space and life comes from international development and urbanization perspectives, describing projects and problems, but not critically assessing how they connect to broader historical shifts in urban spatial governance, planning, and infrastructure (Mohit and others 1994; Rasid and Mallik 1996; M. R. Chowdhury 2003; J. U. Chowdhury and Khondaker 1997; Bala et al. 2009). Recent work on climate change adaptation and flood risk in Dhaka has not tended to treat the historical development of the city's infrastructure in any depth (M. Roy 2009; Jabeen 2014; Jabeen, Johnson, and Allen 2010; Dasgupta et al., 2015).

The following two chapters build off of this and other work to analyze the linked developments of technologies and institutions related to urban planning and urban flood control and drainage in New Orleans and Dhaka respectively.

CHAPTER 2
Banishing the 'Lowland Idea': Flood Infrastructural Modernization in New Orleans

Chapter Overview
Over the course of the 20th century, New Orleans underwent dramatic changes, growing rapidly to accommodate larger populations and shifting settlement patterns with changes in technology and consumer preferences. These shifts were substantially shaped by changes in flood protection and drainage. This chapter traces the history of water management in New Orleans and the simultaneous emergence of the discipline of urban planning as the city grappled with the challenges of enabling growth within a flood prone landscape.

Through a review of archival materials related to New Orleans' spatial planning and flooding and drainage infrastructure, the chapter describes the emergence and evolution of state-led dry city infrastructural modernization. In the decades around the turn of the 20th century, as civic and commercial elites in New Orleans sought to enable the growth and modernization of the city, they formed new public institutions to rationalize growth through coordinated public investments. Early planning efforts for new levees and drainage infrastructure in the city served as precedents and models for the creation of New Orleans' first city planning institutions and plans in the 1920s. Through coordinated action, frequently led by overlapping firms and civic leaders, the city's new hydraulic bureaucracies and city planning institutions undertook major campaigns mobilizing infrastructures like levees, pumps, pipes, and canals to open up vast new territories of low-lying land for urban expansion.

The chapter recounts the evolutions in state-led infrastructural modernization over the course of the 20th century as New Orleans pushed the frontiers of its urban settlements ever further. In the 1920s through 1940s the Orleans Levee Board led a coalition of local bodies in "reclaiming" thousands of acres of shoreline and lake bottom territory along the south shore of Lake Pontchartrain. The effort brought together aggressive flood protection with public-led real estate development. The state-led growth and modernization project included a new airport, recreation areas, and residential areas shaped by contemporary planning fashions for 'city beautiful' formality and 'garden suburb' spaciousness and automobile friendliness.

Starting in the 1950s, city leaders and developers tried to replicate and expand on the lakefront reclamation in the vast swampy lands in eastern New Orleans. Though initially conceived to follow a levee board-led 'growth machine' model like the earlier project, the development of New Orleans East took a different path. Repeatedly stalled and reinvented by boosters, development efforts in New Orleans East were shaped by the growing power of private real estate investors and the increasing influence of federal government agencies in urban flood control. Slowed and altered by lawsuits brought by local environmental organizations under new federal environmental laws, the struggles of the New Orleans East development demonstrates the growing public resistance to Promethean projects of flood infrastructure modernization.

The mounting critiques of levee-led infrastructural modernization in New Orleans came at the same time as a broader state retrenchment, through which the public role in shaping urban growth was diminished in the closing decades of the 20th century. Understanding the rise and fall of state-led flooding and drainage infrastructural modernization is essential to appreciating: 1) the path-dependent patterns of New Orleans' historical growth; 2) the forms of urban infrastructural modernization that were exported from the USA to the Bengal delta and elsewhere during the 20th century; and 3) the

contemporary spatial politics of climate adaptation, wherein growing climate linked urban flood vulnerability is driving a renewal of grand ambitions for state-led infrastructural mega-projects.

Introduction: An Impossible but Inevitable City

In his classic 1976 book on the geography of New Orleans, Pierce Lewis describes the city as the "impossible but inevitable city" (P. F. Lewis 2003b). Lewis' apparently self-contradictory label speaks to the tense relationship that has always existed between New Orleans and its landscape. Outsiders observing the destruction of the city following Hurricane Katrina suggested that the location of New Orleans was a great historical mistake, that it is essentially 'impossible' to maintain a city in the low-lying, flood prone coastal delta environment. Then Speaker of the US House of Representatives Dennis Hastert famously said that much of New Orleans "could be bulldozed," echoing a widely held view that Katrina had revealed the fact that New Orleans was in a fundamentally untenable site and situation. In response to this view, political leaders and advocates for the city made the case that there simply must be a city near the mouth of the Mississippi River, the greatest continental waterway in North America. Even ignoring the city's enormous cultural richness, they argued that New Orleans' ports, industrial facilities, and commerce are essential to the circulation of agricultural, industrial, and mineral products from the interior of the continent and to processing the bounty of the delta's fisheries and oil and gas resources. It is this tension that Lewis identified and that Richard Campanella refers to as "Bienville's Dilemma" (Campanella 2008), alluding to the seemingly impossible choice faced by the French colonial official responsible for locating New Orleans as a commercial and administrative outpost within the inhospitable environment of the lower Mississippi delta.

This chapter recounts how New Orleans has developed in the face of its inevitability and its impossibility through a combination of institutional and technological changes that have radically altered its hydrology. By tracing the linkages between urbanization and flood and drainage infrastructure in the city from its founding through the end of the 20th century, the chapter highlights three main points: 1) shifts in the relationships between local and national water engineering bureaucracies, or hydrocracies (Molle, Mollinga, and Wester 2009), and emerging institutions of city planning have been essential to defining the New Orleans' particular path-dependent patterns of dry city infrastructural modernization; 2) the process of infrastructural modernization in New Orleans has been uneven, episodic, and contested; and 3) these patterns of infrastructural modernization have had distinctly uneven costs and benefits for different constituencies in New Orleans, frequently shaped by the city and region's history of racial discrimination.

"I did not find a better place than where it is": New Orleans' Founding and Colonial Era

From the city's earliest days, New Orleans' residents have struggled to maintain a fixed and stable settlement in a landscape of constant hydrologic flux, increasingly bending the landscape to the needs of urban settlement and expansion. The initial French colonial settlement was located at the current site of the French Quarter, on the relatively high ground of the natural levee in a sharp bend in the Mississippi River. The site was chosen because of its proximity to Bayou St. John, a slow moving creek that wound its way from Lake Pontchartrain, creating a water route used by the native people of the area to connect from the calm waters of the lake to river. Pierre la Blond de La Tour, who, with Bienville, conducted the original survey for New Orleans, reported,

> In going up the river, I examined the best places to establish New Orleans. I did not find a better situation than the place where it is; not only is the land higher, but it is near a bayou, which is a little river, which falls into Lake Pontchartrain, through which one can at times communicate with the New Biloxi, Mobile and other ports, more easily than by the mouth of the river. (Fortier 1904)

While the settlement site was on relatively high ground, it was still vulnerable to flooding from seasonal high water on the Mississippi and from coastal storm-driven floods from the Gulf of Mexico. Within two years of the 1718 founding of the city, both river floods and a hurricane struck, leveling much of the early construction of the city (Morris 2012). Though the early colonists had built small three-foot high earthen levees to protect the new settlement, they were repeatedly overwhelmed.

During the French and Spanish colonial eras (1718 to 1803), settlers in the lower Mississippi gradually built levees upriver and downriver from New Orleans to protect the territory's growing agricultural and urban settlements. While much of this early levee construction was undertaken by private landowners, over time the colonial governments took on a larger role in designing, standardizing, and constructing flood protections. Recognizing the inherent interdependence of residents in this flood-prone landscape, by 1727, the French colonial administration had established standards for levee construction (Morris 2012) and began conscripting slave labor from riverfront plantations to heighten and extend the growing ribbons of earthen levees on either side of the river (Campanella 2008). In response to repeated breaks or 'crevasses' in the private levees, in 1743, representatives of the French crown threatened to take property from riverfront landowners who did not build and maintain levees up to the prescribed standards.

The flood protection infrastructure projects undertaken by the French colonial administration in early 18th century Louisiana mirrored similar efforts in France in the previous century under Louis XIV. Chandra Mukerji has described the levees and seawalls built by Louis XIV "to improve the countryside" and to "give the young monarch greater authority over his kingdom" by making "visible the will of the king and his exercise of dominion over the land" (Mukerji 2007). Mukerji argues that the colonial administrators used the same engineering techniques pioneered for ports and canals in France to build the original levees in New Orleans to make the colonies a "part of France with enough infrastructure to protect, stabilize and improve the land." Nonetheless, the force of the Mississippi and the dynamism of the lower delta landscape repeatedly overwhelmed the efforts of the colonial administration, flooding the young city regularly over the course of the 18th century.

Essayons: The Emergence of Federal Flood Protection

The young US government took over New Orleans and the region as part of the Louisiana Purchase in 1803, one year after the congress created the modern US Army Corps of Engineers (USACE), one of the central institutions that has come the play a pivotal role in the city's flood protection. However, during the entire 19th century, the city's levees remained the responsibility of a patchwork of local governments, state chartered levee boards, and private landowners. In 1810, the city council of New Orleans set new standards for the proportions and construction of the city's levees as part of a larger effort to control the riverfront zone, which had becoming a major site of trade and commerce (Campanella 2008). During high water in 1816, the public levees held, but a crevasse in a private levee upstream flooded much of the city, motivating increasingly strict standards for private levee construction (Morris 2012).

While an 1824 Supreme Court decision confirmed the federal government's authority to make "internal improvements" in accordance to the commerce clause of the constitution, for the next several decades, improvements on the Mississippi were largely restricted to surveys and navigation improvements and did not include construction of flood protection works. In 1849, Sauve's Crevasse, another break in the levees upriver from New Orleans, flooded some 200 blocks of the city. As water poured out of the river channel, residents cut one smaller levee after another to enable sub-basins to drain, allowing flood waters ever further into the city (Campanella 2008). That same year, the federal government took its

first major steps in promoting flood control on the Mississippi River with the passage of the Swamp Act, allowing state governments to sell and lease federal floodplain land to raise money for flood control works (Morris 2012). Over the 1850s, this legislation led to the creation of flood control districts and the Louisiana Board of Swamp Land Commissioners, a body granted taxation authority and responsibility to undertake flood control and reclamation projects. These state-chartered bodies would eventually evolve into levee districts, which became a powerful force in shaping, not only flood control, but urbanization more generally in New Orleans.

The federal role in flood protection in the Mississippi Valley was colored by the particular epistemological and professional character of the USACE. As Shallat has described, the Corps was rooted in a French tradition of civil engineering, where military engineers provided infrastructure to enable planned economic development (T. A. Shallat 1994). As opposed to the more pragmatic trial-and-error rooted model of British water engineering, the West Point-trained engineers who dominated the ranks of the USACE embraced a model of water engineering guided by rational scientific study, rooted in abstract principles. Reflecting this embrace of French engineering and an ethos of bold experimentation, the USACE adopted as their motto the French word, "Essayons," or "let us try."

In keeping with this embrace of scientific inquiry, congress commissioned two different surveys of the Mississippi River and its delta beginning in 1850. The first conducted by civilian engineer Charles Ellet was completed in just two years and recommended a "comprehensive" regional approach to flood control. Ellet's proposal called for not only levees, but also flood retention reservoirs in the headwaters and a system of outlets to allow water to escape from the levees in a controlled fashion during periods of high water so as to avoid uncontrolled levee breaches (Ellet 1852; Kelman 2003). The second report, the Delta Survey by Andrew Humphreys, chief engineer of the USACE, and military engineer Henry Abbot, was not released until 1861. The Humphreys and Abbot survey rejected Ellet's "comprehensive" approach and argued for a strategy focused on confining the river in levees. They argued that the levees were the only way to restrict the river to definite banks. They also recommended levees as a means of increasing the river's flow velocity to reduce sedimentation and keep the navigation channel open (Kelman 2003; T. A. Shallat 1994). It was Humphreys and Abbot's so-called "levees-only" approach that would come to dominate infrastructure investments on the lower Mississippi for the next several decades, locking the region into a pattern of building higher levees, which in turn brought higher flood stages as water could not spread over the landscape. To respond to these increased flood stages, the Corps raised the levees further.

Though the USACE embraced the levees-only approach to flood control in the Mississippi Valley during the second half of the 19th century, a lively debate continued about the strategy's benefits and costs. In an 1897 article in *National Geographic*, E.L. Corthell recognized that the Mississippi's levees had already disrupted the dynamic equilibrium by which annual high water deposited sediments in the lower delta, counteracting the effects of broad landscape scale subsidence. Corthell predicted that "a complete system of absolutely protective levees" would lead to "the subsidence of the Gulf delta lands below the level of the sea and their gradual abandonment" (Corthell 1897). In the end, he predicted that "the great benefit to the present and two or three following generations" that would come from levee-enabled development in the delta would be so great as to justify later investment "to build a protective levee against the Gulf waters" for the entire region. As precedents, Corthell cited the small scale levees that then protected New Orleans and the "great projected reclamation of the lands submerged by the Zuyder Zee" in Holland. Like the Ellet delta study, Corthell's account indicated that 19th century observers were well aware of the long-term dangers of leveeing the Mississippi. Driven by an overwhelming faith in the advancement of science and technology to solve whatever problems might

emerge from the shortsighted leveeing strategy, the Corps proceeded to build ever more aggressive flood protections along the lower Mississippi.

Levee construction was the dominant strategy deployed throughout the 19th century to keep water from the Mississippi River from flooding New Orleans and other riverside settlements. Nonetheless, even under normal river conditions, the amount of dry land available for urban expansion in the region was sharply limited. Meanwhile, westward expansion from the eastern regions of the USA and increasing freight traffic on the Mississippi fed booming growth in the region's economy and population. In 1810, just a few years after the Louisiana Purchase, the population of New Orleans stood at just over 17,000. By 1900, the city had grown nearly to nearly 17 times its 1810 population to over 287,000. While the city's early settlements were nestled on natural ridges, by the mid-19th century the area of settlement had grown substantially, pushing into the low-lying swampy lands further away from the Mississippi. Beginning in 1836 and extending through 1871, private companies started using mechanical paddle wheel drainage machines to drain low lying areas within New Orleans to expand the territory available for settlement ("About the Orleans Levee District" n.d.). In 1870, private companies began excavating canals to drain the marshes along the shores of Lake Pontchartrain. Though the venture failed commercially, their excavations were revived around the turn of the century as development pressure continued to press further into the swampy lands in the "back of town" (Campanella 2008).

In the face of persistent flooding and mounting demand for land, city leaders ramped up plans for flood control and reclamation projects over the late 19th and early 20th century. In 1871, a group of local leaders put forward the first proposal for an integrated system of levees and canals to protect and drain the city (Campanella 2008). Two years later, W.H. Bell, the city surveyor put forward his "Plan of Property Improvements for the Lake Shore Front of the City of New Orleans" calling for a combined land development and flood control infrastructure project for the low-lying marshlands along the southern shore of Lake Pontchartrain ("About the Orleans Levee District" n.d.). While Bell's scheme for the lakefront did not proceed, it foreshadowed future urbanization in which flood control and urban growth were integrally linked through major public infrastructure investments.

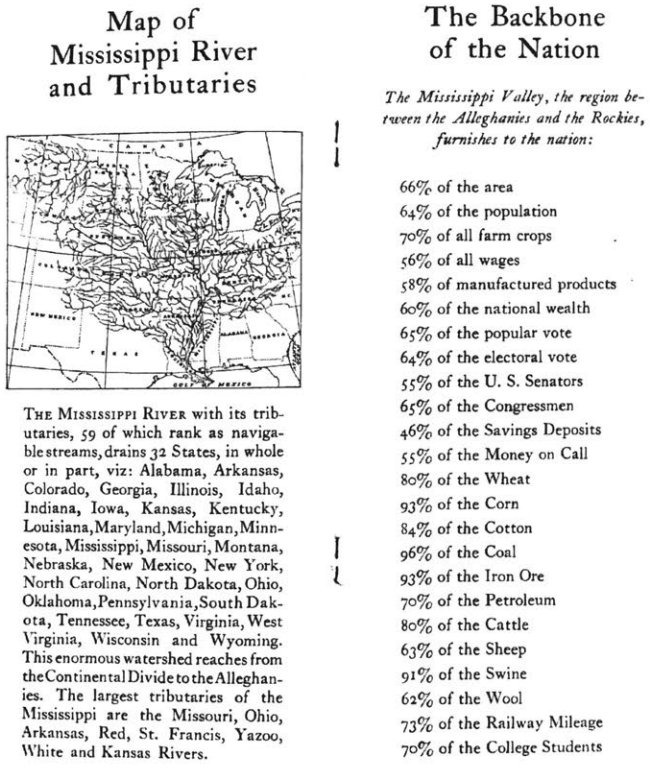
Over the final decades of the 19th century and the first decades of the 20th, the trends of the 19th century accelerated with increasing attention to Mississippi River flooding from the federal level and tighter linkages between urban growth and water management at the local level. In 1879, congress created the Mississippi River Commission (MRC) to "improve and give safety and ease to navigation" and to "prevent destructive floods" on the river. After especially destructive flooding led to nearly 300 levee failures on the river in 1882, the MRC was reorganized and new standards were issued to meet elevated flood levels. Levee districts were authorized statewide in Louisiana in 1886 and the Orleans Levee Board and Board of Levee Commissioners was created in 1890 (Campanella 2008). Following yet another year of heavy flooding, the Rivers and Harbors Act of 1890 authorized the federal government to build flood protection levees for the first time. As Corthell and others had described, with the larger investment in levees, seasonal high waters on the river were disconnected from the surrounding floodplains. River levels and flood events continued to rise. From 1717 to 1799, there was a major flood on the river every 5.8 years. Between 1801 and 1927, the frequency increased to every 2.6 years (D. W. Davis 2000).

While the federal government's role in flood control on the lower Mississippi had been steadily expanding for several decades, it was only after the "Great Flood" of 1927 that the US Army Corps of Engineers became the primary institution responsible for designing and building levees along the river. The central government's investments in infrastructure on the river had long been justified on the basis that "internal improvements" were a matter of interstate commerce. However, with decades of

concerted lobbying by landowners in the Mississippi Valley, the federal government had gradually become more central in shaping the relationship between land and water in the region in ways that were not directly related to navigation or interstate commerce. Karen O'Neill argues, this turn-of-the-century expansion of the federal role in flood control constituted a transformative change in the role of the national state in the USA (O'Neill 2006). 1927 was among the most critical moments in this transition. In the wake of the 1927 flood, a pamphlet for a flood control conference made explicit the link between nationalism and flood control infrastructure in the Mississippi Valley, from its title, "America First," to its urgent pronouncements such as,

> IF UNCLE SAM PERMITS THIS VALLEY TO GO TO RUIN THROUGH FLOOD DISASTER THE PROSPERITY OF THE NATION IS DESTROYED

Statements from prominent politicians included in the pamphlet make the case that flood control in the Mississippi Valley is "a national problem," a "threat and challenge to the entire nation," and even "a challenge to our very civilization" (Figure 2.1) (Flood Control Conference 1927). After the 1927 floods, the 1928 Flood Control Act enabled the largest public works appropriation in American history to that point, a substantial portion of which went to initiating the Mississippi River and Tributaries Project (MRTP). The MRTP strengthened the levees along vast stretches of the river system. However, the MRTP also marked a decisive shift away from the "levees only" policy of the previous decades, authorizing the construction of several major spillways, engineered structures that could be opened during high water to release pressure on the levees through controlled release into floodable landscapes.



Map of Mississippi River and Tributaries

THE MISSISSIPPI RIVER with its tributaries, 59 of which rank as navigable streams, drains 32 States, in whole or in part, viz: Alabama, Arkansas, Colorado, Georgia, Illinois, Idaho, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Dakota, Tennessee, Texas, Virginia, West Virginia, Wisconsin and Wyoming. This enormous watershed reaches from the Continental Divide to the Alleghanies. The largest tributaries of the Mississippi are the Missouri, Ohio, Arkansas, Red, St. Francis, Yazoo, White and Kansas Rivers.

The Backbone of the Nation

The Mississippi Valley, the region between the Alleghanies and the Rockies, furnishes to the nation:

66% of the area
64% of the population
70% of all farm crops
56% of all wages
58% of manufactured products
60% of the national wealth
65% of the popular vote
64% of the electoral vote
55% of the U. S. Senators
65% of the Congressmen
46% of the Savings Deposits
55% of the Money on Call
80% of the Wheat
93% of the Corn
84% of the Cotton
96% of the Coal
93% of the Iron Ore
70% of the Petroleum
80% of the Cattle
63% of the Sheep
91% of the Swine
62% of the Wool
73% of the Railway Mileage
70% of the College Students

Figure 2.1. Making flood control on the Mississippi a national project. "America First" (1927)

Sacrificial Landscapes and Uneven Vulnerability

While the 1927 flood signaled changes in the extent and character of the federal flood control on the Mississippi River, it was also a pivotal event in the politics of flood protection locally in New Orleans, illustrating the uneven balance of power between urban and rural interests in the region. With record high water on the river and levee breaches upstream from New Orleans, authorities authorized the dynamiting of the levees downstream in St. Bernard Parish to relieve pressure on the city's levees and lessen the risk of a catastrophic failure (Barry 1997). While the intentional breaching of the levees in St. Bernard Parish may have protected New Orleans from flooding, it also clearly demonstrated that, with greater central control over the region's waters, not all areas or populations could count on equal protections. Thousands of rural residents of St. Bernard Parish were displaced and their hunting, trapping, and fishing livelihoods disrupted or destroyed by the breaching of the levees. The sacrificial flooding of these rural areas has continued to resonate in discussions of south Louisiana flood control for the decades since. The persistent rumors that officials dynamited levees protecting predominantly African-American neighborhoods like the Lower 9th Ward during Hurricane Katrina were one particularly visible instance of an historically-rooted distrust between the region's poorer residents and the hydrocracies that are widely regarded as representing the interests of urban elites (Lee 2006). Rural residents and the urban poor of New Orleans remain justifiably suspicious that their flood safety is conditional and might be revoked at any point for the benefit of wealthier and more politically powerful interests (J. A. Lewis and Ernstson 2017).

The Nexus of Growth and Modernization with Drainage and Flood Protection

As the state and federal governments ramped up efforts to build flood protection infrastructure in the latter years of the 19th century, the local government in New Orleans similarly organized increased investment in public drainage efforts. Following extensive flooding from heavy rains in 1894, the New Orleans Drainage Commission was organized and released its plan for an improved drainage system in 1896 (Kelman 2003). As in many other rapidly growing cities at the time, these drainage improvements were framed as marshaling modern science and engineering in the cause of public health, hygiene, and sanitation. The linkages between early planning efforts and sanitation and public health has been well-documented in cities from London and Paris (Choay 1969; Gandy 1999b) to colonial India (McFarlane 2008; Gandy 2008). The next chapter includes discussions of a similar sanitation-based drainage movement for "civic improvement" in Dhaka during the late 19th and early 20th century.

Following a yellow fever outbreak, in 1899 the New Orleans Drainage Commission was absorbed into the newly formed Sewerage and Water Board (SWB), the primary institution responsible for the networks of pumps, pipes, and canals that remove water from the leveed areas of city of New Orleans even today (City Planning and Zoning Commission 1926).

These drainage efforts enabled the steady expansion of New Orleans' urban footprint into the surrounding marshes and cypress swamps, substantially accelerating after 1913. In that year A. Baldwin Wood, an engineer who would later become the SWB's director, invented a new more efficient and robust pumping technology (P. F. Lewis 2003b). The "Wood Screw Pump" made possible the drainage of vast areas of formerly uninhabitable swampland, speeding the spread of urbanization and necessitating expanded levees to keep the surrounding lakes and bayous from spilling water into the newly drained lands. Over the three decades from the mid-1890s to the mid-1920s the drainage pumping capacity installed in New Orleans increased nearly tenfold, from 1,214 cubic feet per second (CFS) 1894 to 10,495 CFS (City Planning and Zoning Commission 1926). With this new pumping technology and with 1922 state legislation allowing levee boards to raise funds by leasing, selling, or renting reclaimed lands, the Orleans Levee Board (OLB) became a central player in New Orleans' state-led, drainage-dependent

'growth machine' (Logan and Molotch 1987). In 1900, flush with confidence in the growth of the city, the Drainage Commission estimated that the core of the city, not including the undeveloped lakefront neighborhoods or the vast area that would become New Orleans East, would eventually house some 855,000 people (City Planning and Zoning Commission 1926). As a point of comparison, the entire city of New Orleans, in a much-expanded territory, peaked in population at less than 630,000 in 1960.

A 1922 pamphlet entitled "What the Orleans Levee Board is Doing for the People of New Orleans" placed flood protection and urban expansion as coequal goals of the OLB, stating that,

> The duties and responsibilities of the Orleans Levee Board are twofold... the protection of this City from overflow, both from river floods and lake storms... [and] the development of the shores of Lake Pontchartrain into parks and residential sites.

The pamphlet explicitly states that the "development of the shores of Lake Pontchartrain" is a "responsibility" that is "second and just as important" as the flood defenses "against dangers of Nature's making" (Garsaud 1922). In 1928, the same year that a new federal Flood Control Act radically increased the role of the national government in flood infrastructure provision on the Mississippi, state legislation in Louisiana empowered the OLB to "reclaim" some 2000 acres of land along a 5.5 mile-long stretch of the southern shore of Lake Pontchartrain, realizing a vision first set out in 1870. Over the next two decades, the OLB carried out the ambitious New Orleans Lakefront Project, which linked flood control, in the form of new levees, canals, and seawalls along the lakefront, to the development of an entirely new suburban district. The project included 600 acres of new parks and open space, including Pontchartrain Beach, a recreational beach and amusement park. To pay for the new flood control structures and public amenities, half of the newly created land was sold to private developers for suburban residential and mixed-use development. The project included over 1000 acres of new suburban residential building sites, including nearly 850 new home sites in Lake Vista, a City Beautiful neighborhood whose homes fronted on landscaped pedestrian paths inspired by the new town at Radburn, New Jersey (Perez and Thompson 1950; P. F. Lewis 2003b). A 1950 OLB pamphlet describes the new lakefront neighborhood as, "a modern subdivision well planned, with underground service for utilities, and with beautiful parks and a Lakeshore drive" (Perez and Thompson 1950). Together with the adjacent area whose development would be facilitated by the flood control structures, the project was projected to create enough residential property to house some 78,000 people in spacious modern suburban-style homes (Orleans Levee Board 1954).

The initial plan for the lakefront development was conceived by Harland Bartholomew, the St. Louis-based planning firm that would also develop New Orleans' first zoning ordinance and master plan. The Harland Bartholomew proposal is very much a product of its time, bringing together a central focus on efficiency and rational planning with a City Beautiful emphasis on symmetry and monumental composition (Figure 2.2). The plan maximizes salable residential lots on gridiron streets with the introduction of a few curved streets "for the purposes of pictorial interest" (Harland Bartholomew and Associates 1928).

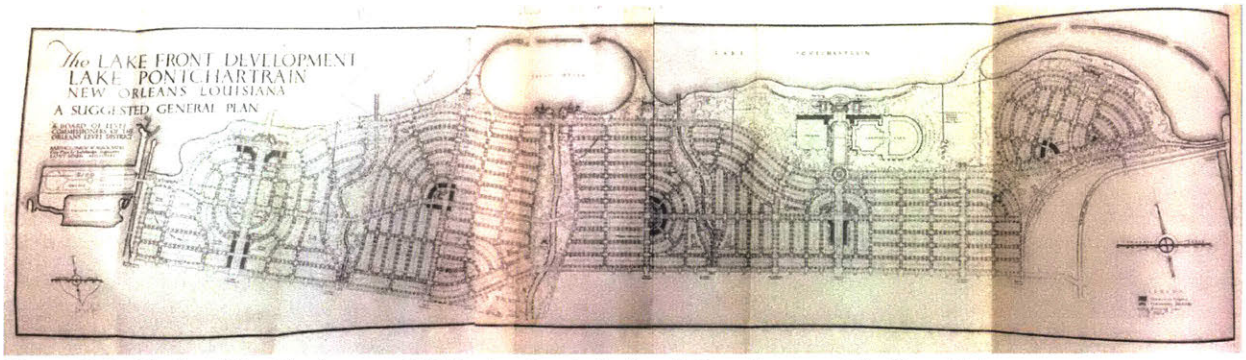


Figure 2.2. Harland Bartholomew 1928 plan for Lakefront Development in New Orleans.

The 1928 Harland Bartholomew plan largely avoided issues of drainage and flood control. In fact, the planners explicitly rejected including lagoons or lakes out of concern that they would reduce the area of salable lots, interfere with the city's engineered canals and pumps, and "accentuate the lowland idea, which in New Orleans seems inappropriate." The idea that it would be "inappropriate" to "accentuate" the "lowland" character of the region directly contradicts contemporary flood resilient urbanism planning ideas, which call for the distribution of flood retention spaces throughout the urban fabric, both for hydrological reasons and to remind residents of the natural hydrology of the region. Rather than treating water management as an element of their plan, Harland Bartholomew adopts the OLB's flood protections and the SWB's drainage works as existing conditions into which their spatial scheme must fit, using the planning best-practices of the time. The planners remarked that their scheme was shaped by a "respect for the canals and their undisturbed operation, for the outlines and cross section of the present fill with but very slight modification" (Harland Bartholomew and Associates 1928). In the lakefront development, the planners went out of their way to de-accentuate the role of flood protection in the project, saying "the main value of this development will not be merely in furnishing protection against high water and erosion of the lake." Rather, in keeping with the broader planning emphasis on order, efficiency, and property value preservation, the report asserts that "the main value from a residential standpoint at least, will lie in having an area of size comprehensively protected against the inroads of uncertain use." (Harland Bartholomew and Associates 1928)

Though the lakefront reclamation project was slowed by weak housing demand during the Great Depression, it continued throughout the 1930s and 1940s. In addition to making space for the mid-century car-dependent suburbs, the lakefront development also created new public facilities befitting a growing modern metropolis. Public facilities in the area included two new universities, LSU-New Orleans (now the University of New Orleans) and the historically black university, Southern University New Orleans. The area also came to house a new public arena, a new headquarters for the Orleans Levee District, and several large parcels that were occupied by military uses during and after the Second World War.

Perhaps the most symbolically potent public component of the lakefront development was Shushan Airport, the city's first modern civilian airport, built on a triangular spit of manmade land jutting into Lake Pontchartrain just east of the Industrial Canal. The airport was dedicated as "The Nation's Most Modern Airport" in 1934 and named in honor of Abe Shushan, a prominent local businessman and Huey Long ally who headed the levee board during the lakefront development process (Orleans Levee Board 1934). The airport's primary buildings were designed by the same New Orleans architects who designed the 1932 state capitol in Baton Rouge as a towering monument to Huey Long's vision of progressive politics. A commemorative pamphlet celebrating the opening of the new airport exhaustively describes

the facility as a triumph of engineering and a marvel of modern design. In drawings, photographs, and text, the pamphlet celebrates the innovative landfilling techniques used to enable the airport, which "juts out like a mighty arrowhead from the south shoreline into the blue water of Lake Pontchartrain." It celebrates the murals, sculptures, modern lighting, and luxurious materials such as terrazzo floors, marble walls, and ornamental plaster ceilings of the Art Deco terminal building. One of the repeated decorative motifs of the building was the depiction of "the conquest of distance by the airplane," placing the new airport facility as a key feature of New Orleans' modernization. The pamphlet describes the airport's construction as "another instance where the Orleans Levee Board has come to the rescue," in a "story of great enterprise" to provide a "modern airport" as an essential component of "a really progressive American City (Figure 2.3) (Orleans Levee Board 1934). The pamphlet celebrates the airport project as an act of Keynesian counter-cyclical public investment, remarking that its $3,000,000 expenditure was made "at a time when disturbed world financial conditions depressed commerce and industry" (Orleans Levee Board 1934). Similarly, federal New Deal funds were mobilized through the Works Progress Administration to fund some of the roads and public structures built as part of the lakefront development.

Figure 2.3. Cover art for the booklet commemorating the opening of Shushan Lakefront Airport, part of the effort to use the flood control and reclamation project on Lake Pontchartrain as a means of modernization. (1934)

The new airport, along with the other components of the lakefront development project, positioned the OLB as a primary actor in shaping urban space in New Orleans during the mid-20th century. In 1928, C.A. Favrot, a prominent business man and civic activist who was a member of the first New Orleans Planning and Zoning Commission, celebrated the vision of the lakefront development and urged his fellow citizens towards greater civic ambition saying,

> It is true this [the New Orleans lake front development] is the biggest piece of work ever undertaken in the City of New Orleans. However, we cannot be a big city unless we undertake big things. We are not in a village class. If we are going to be a big city I do not think we can look upon such little things in development as being a huge proposition... We must go at it in the proper spirit; and I think if we do not go into this we are losing an opportunity to show that we have aspirations for the future (Orleans Levee Board 1954).

By converting swamps, marshes, and lake bottom land into new territory for urban expansion, leaders of the OLB and the SWB, turned the city's flood vulnerability, which had long been its chief handicap, into an advantage. With the application of rational study and ambitious engineering, the thousands of acres of flood-prone land that surrounded the city could serve as a strategic reserve of land, allowing the city to periodically renew itself through growth and modernization. Without major investments in flood protection and drainage infrastructure, the surrounding landscape was largely inhospitable to settlement. The flood-prone territory surrounding the city were held by relatively few owners, including, in the case of the foreshore and bottom of Lake Pontchartrain, the State of Louisiana. As such, because the hydraulic bureaucracies of New Orleans were able to mobilize public resource for major infrastructure investments, they were able to undertake large-scale planned urban expansions, which would be unfeasible in other cities without such formidable barriers to small-scale private development.

The dry city infrastructural modernization projects led by the OLB and the SWB were nominally focused on creating comprehensive public benefits, but these benefits were highly uneven in their distribution. In the case of the 1920s lakefront development, the new high end and upper middle class lakefront neighborhoods created by the project were filled to an elevation of five to ten feet above the mean lake water level, creating the relatively flood safe northern rim of the city's now-famous bowl-shaped topographic profile. However, the residential development impact of the lakefront reclamation went well beyond the bounds of these northern rim neighborhoods of Lake Shore, Lake Vista, Lake Terrace and Oaks. With the construction of the OLB's seawall and its elevated lakefront neighborhoods, large areas were hydrologically separated from the lake waters, enabling development on the low-lying land to the south, between the new reclamation and the already settled areas stretching back from the Mississippi River.

While the lakefront reclamation project can be seen as part of a comprehensive infrastructure scheme in that it provided flood mitigation for a broad territory, the flood depth maps showing levels of inundation that followed the levee breaks of Hurricane Katrina clearly illustrate the unevenness of these protections (Figure 2.4). While the elevated and reclaimed areas nearest the lakefront were minimally impacted, the Lakeview and Gentilly neighborhoods, whose development was enabled by the OLB reclamation, were devastated. With the legacy of informal and formal racial segregation (racial deed restrictions were among the stated virtues of the OLB's lakefront suburban development), this uneven vulnerability translated into increased risk in many of New Orleans' African-American neighborhoods. Racial segregation also meant that black New Orleanians were either excluded from many of the OLB's public facilities or were relegated to inferior segregated options. The city's African-American population was barred from entry to the Pontchartrain Beach facilities created in the lakefront redevelopment.

Lincoln Beach, the African American swimming beach built by the OLB, was only built decades later and it was located in the far reaches of eastern New Orleans.

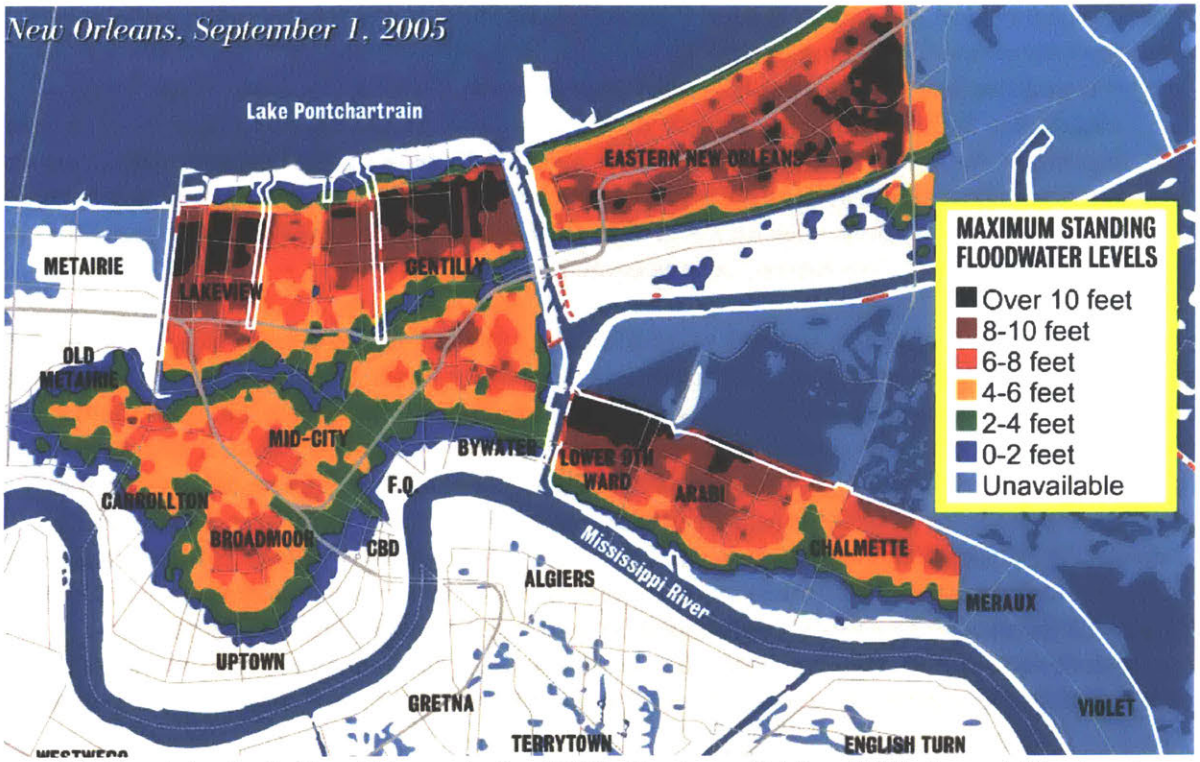


Figure 2.4. Flood depths in New Orleans during 2005's Hurricane Katrina. While the neighborhoods reclaimed from Lake Pontchartrain in the 1920s and 1930s saw relatively little flooding, Gentilly and Lakeview, whose development was enabled by the same project are considerably lower and received much more damage. (*Times-Picayune*)

Flood Protection and Drainage Inspires the Emergence of City Planning in New Orleans

At the same time that New Orleans' hydrocracies were forming and taking a leading role in directing the growth of the city, city planning emerged as a discipline and professional practice in cities around the USA. By the early 1920s, many of the same civic and municipal leaders responsible for New Orleans' early 20th century drainage and levee projects were also mobilizing to bring the tools of city planning to bring order, efficiency, and aesthetic control to the city's growth. In fact, the turn-of-the-century drainage and flood control efforts, were a model for nascent city planning efforts and set critical spatial conditions within which future planners would operate. Over the course of the early 20th century, New Orleans continued its rapid spatial and demographic growth. In 1890 the city had a population of just under 250,000 residents. By 1940, the population had nearly doubled to over 490,000. While New Orleans' earliest formal city planning efforts in the 1920s were inspired and shaped by the water management projects underway in the city at the time, these early plans did not directly engage with questions of drainage or flood control. Rather, they concentrated on bringing rationality, order, and visual appeal to a city that leaders regarded as crowded and chaotic.

As in other rapidly growing southern cities like Memphis and Atlanta, city planning emerged in New Orleans at the urging of the city's civic and commercial elites (Brownell 1975). Early efforts to advocate for systematic planning in New Orleans arose out of the city planning committee established by the Association of Commerce, a coalition of growth-oriented private businessmen in the city (City Planning and Zoning Commission 1926). The Louisiana state legislature passed the state's first city planning and

zoning enabling legislation in 1918. The next year, local commercial leaders funded a series of 52 weekly newspaper columns written by Philadelphia planner Milton Bennet Medary, Jr. in which Medary laid out the case that planning and zoning were necessary to ensure the health and prosperity of growing American cities. By 1923, municipal leaders and prominent citizens had formed the first City Planning and Zoning Commission (CPZC). In 1926, the Commission hired Harland Bartholomew to draft the city's first zoning ordinance, a preliminary draft of which was issued for comment in 1927. After a series of public meetings and revisions, the city's first comprehensive zoning ordinance (CZO) was adopted in 1929.

The CPZC was initially composed largely of prominent local businessmen with a particular bias towards professionals from the engineering, construction, architecture, real estate, and banking sectors (Brownell 1975). There was significant overlap between the members of the CPZC and the civic leaders active in pushing forward the flood control and drainage infrastructural modernization in New Orleans. The first chairman of the CPZC was C.A. Favrot, who, in 1928, had celebrated the lakefront reclamation project, saying "we cannot be a big city unless we undertake big things" (Orleans Levee Board 1954). Among the Commission members listed in the handbook released with the first CZO were several people who had served in both political and technical capacities on the SWB and OLB, including: Abe Shushan, the OLB chairman for whom the lakefront airport was named; John Klorer, the former City Engineer and the chief OLB engineer for the lakefront development project; and A. Baldwin Wood, the superintendent of the SWB whose pump design had enabled the drainage of the city's interior (Bartholomew 1929).

Given the overlaps among the municipal and civic leaders responsible for the infrastructural modernization of drainage and flood control and those involved in early comprehensive planning and zoning efforts, it is perhaps not surprising that early planning documents reference New Orleans' turn-of-the-century drainage plans as important precedents for the comprehensive planning work that got underway in the 1920s. In the city's first planning studies, the authors from Harland Bartholomew repeatedly allude to the ways that New Orleans' hydrological situation had shaped the city's history and growth. The 1926 "Major Streets" report, which was at the heart of the first comprehensive planning effort, spoke of the city's "long struggle against handicaps and unfavorable influences." Linking the city's historical struggles for progress against topographic, sanitary, and security obstacles, the report says,

> Since that far-off day [of the city's founding] the draining, the building and rebuilding, the battle against high waters, epidemics, and enemies and against the elements which held back highways and railroads and trade advantages have been unceasing. (City Planning and Zoning Commission 1926)

The planners presented the historical development of New Orleans as an epic battle against chaos and epidemic in which topography and flooding played a central role, saying

> The greatness of New Orleans hung in the balance of many years. The tipping of the scales depended upon a solution of the drainage problems resulting from the natural ground levels of the site (City Planning and Zoning Commission 1926).

In this epic drama, flooding and its threats to health and prosperity were cast as the great villains and the Drainage Commission and its successor, the SWB, emerge as the heroic victors. The "Major Streets Report" says, "it is no small victory which New Orleans has won" its battle against flooding and that, "too much credit cannot be given to the men who conceived the plan and which made this conquest possible" (City Planning and Zoning Commission 1926). Critically, the Harland Bartholomew reports describe New Orleans' struggle as an *historical* struggle, a *past* victory, which has set the stage for the city's next transition to greatness. They celebrate the far-sighted leaders who had the "vision, initiative and ingenuity, and the courage to seek the enormous funds to carry out such a program" in order to

achieve "permanent elimination of ground water in the low areas" of the city (City Planning and Zoning Commission 1926). They report, that though "New Orleans has attained its present stage of growth despite innumerable handicaps," the city's "position is essentially sound" (Bartholomew 1931). They concluded that "future disasters" are "less likely to occur" than before because of the "extensive engineering works, flood protection, improved scientific methods of fighting disease, extensive sewerage and water facilities and many other similar public improvements." (Bartholomew 1931)

In celebrating the "conquest" of the city over its flood problems, the Harland Bartholomew positioned the drainage plan and infrastructure investments as a clear precedent for the comprehensive planning and zoning that they proposed for New Orleans. The Major Streets Report outlines the stepwise process through which the Drainage Commission conducted scientific studies to inform comprehensive, long-term, rational plans, which were then systematically carried out through coordinated investment. In celebrating the rational, systems-oriented approach to the earlier effort, they explicitly make the link between the Drainage Plan and "city planning" more broadly, saying,

> All of this work is proceeding along lines laid down many years ago by the engineer's committee of the Drainage Commission, who made the initial studies and surveys for the Sewerage and Water Board. This point deserves special emphasis here. The work of these engineers was city planning of a most valuable kind. They took a broad view of the future city. They anticipated growth. They drew plans which were comprehensive. As a consequence, the drainage plan has been carried out with a notable economy of effort. The system functions as a system. Things fit together. (City Planning and Zoning Commission 1926)

In pursuing this systemic vision, the Report remarks that the Drainage Commission demonstrated a bold and persistent public spiritedness, showing that "there can be no stopping because of local, selfish interest" (City Planning and Zoning Commission 1926). Appealing to civic pride and a sense of collective destiny, they go on to say of the Drainage Commission's infrastructural modernization, that "the work had to be done, regardless of the cost, if New Orleans was to hold its proper place among the great cities of the world" (City Planning and Zoning Commission 1926). Then, linking their own comprehensive planning and zoning project to this previous effort, they say "The same broad, enlightened view must be taken with respect to other problems of city development" (City Planning and Zoning Commission 1926).

While the major planning and investments of the SWB and OLB had set up the conditions for a major expansion of urban settlements in New Orleans, the Harland Bartholomew planners also identified federal water infrastructure investments as a larger-scale driver of the city's future prosperity. Celebrating the growing federal role in flood control and navigation, the planners reported that "the development of our great inland waterway system including both the Mississippi River and its tributaries, will greatly increase the prestige of New Orleans" (City Planning and Zoning Commission 1926).

While the membership of the early city planning bureaucracies shared considerable overlap with that of the drainage and flood control institutions and the early comprehensive planning and zoning efforts repeatedly invoke the "conquests" and "victories" of the earlier drainage plans as precedents for their own efforts, these early forays into city planning in New Orleans largely avoided substantive engagement in the city's drainage and flood control problems. The Harland Bartholomew plan adopted in 1929 did not include any significant consideration of how flood vulnerability or drainage might shape future growth in the city. In spite of the central importance of drainage and flooding to the historical development of the city, the *Handbook to the Comprehensive Zone Law for New Orleans Louisiana,* does not list any water or drainage related topics as among the "chief component parts" of the plan, which included: surveys and specific studies on major streets, subdivisions, transit, railroads, recreation, civic

art, zoning, the port, industry, and regional issues. Rather, the planners largely treated drainage and flooding as an issue that had been resolved separately from their otherwise "comprehensive" planning effort.

The plan also did not significantly engage with the implications of the massive lakefront reclamation and development project that was underway at the time. It simply considered the project and other contemporary drainage and flood control works as setting the conditions for the expansion of the city. In laying out the case for a comprehensive plan, the Major Streets Report asked rhetorically,

> Is any agency planning the coordinated schools and parks and pleasure drives in the district bordering the lake, which after the operations of the Levee Board are complete, will become a new city? (City Planning and Zoning Commission 1926)

Rather than helping to determining where and when drainage and flood control works might be undertaken, the 1929 plan portrays the role of city planning as coordinating the orderly deployment of urban resources into the new territories created by the SWB and OLB. They note that, "many acres of New Orleans territory that have been made habitable by the work of the Sewerage and Water Board are not yet in use" and that "since public funds to the extent of millions of dollar have already been invested in these areas, every effort should be made to encourage the spread of new population into them rather than into areas lacking such advantages" (City Planning and Zoning Commission 1926). In this schema, New Orleans' hydrocracies determined where and when the city would expand. Only then were planners to develop plans for the orderly and efficient deployment of other infrastructures to enable growth into these newly accessible areas.

With investments in water infrastructure from the federal and local governments, the 1929 plan presented New Orleans as a city at a pivotal point in its history. The Harland Bartholomew planners regard New Orleans' historical struggles with flooding as having held the city back from competing with its peer cities. Describing the role of drainage in shaping intercity competition, they point out,

> For nearly a century, while other cities were steadily perfecting the advantages and comfort of urban life, the people of New Orleans were struggling against the handicaps imposed on their community by the low level of the site. In 1900, New Orleans was far behind sister cities of this country in elemental public utilities. (City Planning and Zoning Commission 1926)

In the presentation of this plan, having achieved the "conquest" over the city's water struggles through the skillful and visionary application of engineering in the Drainage Plan, the final impediment restraining New Orleans from achieving its rightful place was a lack of proper planning. Appealing to the ambitions of city leaders, the planners reported that,

> All of these factors point to the need for a city plan commensurate in character and scale with the city's future greatness. (City Planning and Zoning Commission 1926)

While the planners and city leaders behind New Orleans' first plans clearly saw investments in water infrastructure as central to the growth and prosperity of the city, they did not consider it part of their scope to direct (or even comment on) when, where, and how such infrastructure should be deployed. Though the plans focused on the application of rational study to developing plans through which "New Orleans can grow to be a more orderly, efficient, and beautiful city," these efforts remained constrained to rationalizing land use and infrastructure development in the existing city territory and those new lands created by recent reclamation efforts (Bartholomew 1929). Early components of the Harland Bartholomew plan reported that the final plan would provide a

> complete program of physical improvements correlated with the several special plans of the Levee Board, Dock Board, Public Belt, Sewage and Water Board, City of New Orleans and other agencies engaged in building for a larger, greater city (City Planning and Zoning Commission

1926).

The primary tools used by these early planners was the new Comprehensive Zoning Ordinance (CZO), which CPZC chairman C.A. Favrot argued would apply "reasonable technical study" of the city to enable "proper city progress" (Bartholomew 1931). In keeping with the rational planning practices of the time, the Harland Bartholomew planners described zoning as,

> a conscious, intelligent effort to direct the building of the city in accord with a well-considered plan. Like good housekeeping, it provides a place for everything and tries to keep everything in its place. Like good industrial management it plans for an orderly growth and expansion of the plan (Bartholomew 1929).

The CZO was to be the primary regulatory tool of the plan and it was intended to provide a number of functions, including: land value preservation, traffic congestion relief, fire safety, ensuring adequate "light and air," and guiding utility provision. Water management was just one of many forms of infrastructure mentioned in the CZO and it was less emphasized than other issues, such as traffic congestion.

While this first plans were largely focused on efficiency and rationalization of urban growth, they were also colored by the "City Beautiful" ideas dominant at the time. Concern for protecting and enhancing the beauty of the urban environment took the form of studies and recommendations on "civic art," which included public plazas, historic preservation, and monuments. Civic art also encompassed proposed regulation of built environment elements such as canopies, balconies, street lighting, and signage. The plan also put forward recommendations to increase the amount and distribution of parks and other recreational facilities. As in other areas of the 1929 plan, recommendations related to open space and the aesthetic experience of the city were largely focused on establishing standards to rationalize the existing fabric of the city and setting out a course for how newly reclaimed areas would be urbanized. These matters of urban green space and the aesthetic experience of the city were considered to be entirely separate from questions of urban water management, drainage, and flood control.

The relative disengagement of the newly formed city planning bureaucracies and planning consultants on issues of water management meant that, by default, New Orleans' relationship to its watery landscape was defined by the hydraulic bureaucracies of the SWB and the OLB locally and the US Army Corps of Engineers at the national level. With these hydrocracies driving the agenda of water management, there continued to be a stark divide between questions of urban form and issues of infrastructure investment. Engineering bureaucracies would propose, plan, and build new levees, pumps, canals, and pipes to turn swamps, marshes, and lake bottoms into land suitable for urban settlement. To the extent that spatial planners and designers were engaged in these processes, the urban form that they proposed tended to be driven more by changing national planning practices and fashions than by the particular hydrological or topographic conditions of these sites.

"The Orleans Levee Board is Big Business": Levee-Driven Growth in the Mid-20th Century

After emerging as a major force in shaping the growth and form of the city in the 1920s and 30s, the OLB continued to play a leading role in New Orleans' growth machine over the course of the mid-20th century. The lakefront development had been a central part of advancing a new assertive and progressive vision of a modern New Orleans. A 1950 OLB pamphlet described the benefits of the project, linking aesthetic order and hazard reduction, saying, "gone are the jerry-built camps, the scattered light poles, and the danger of rising water" (Perez and Thompson 1950). In this narrative, the OLB played a central role in a mythical struggle, harnessing the powers of engineering and design to fight against

poverty, isolation, environmental hazards, and disorder to bring forward a new era of connectivity, prosperity, and aesthetic order and beauty. A 1954 OLB annual report (Figure 2.5) encapsulates this Promethean vision, describing how the dangers of the waters surrounding New Orleans had been triumphantly subdued,

> [M]an has harnessed these waters to do his bidding. He has confined the river with levees, by-passed its floods through spillways. He has reclaimed thousands of acres of swampland; transformed an ugly, mosquito-infested shoreline into a world renowned garden spot of beauty and usefulness. He has safeguarded the health and assured the orderly growth and expansion of the community by providing building sites for homes and industries. (Orleans Levee Board 1954)

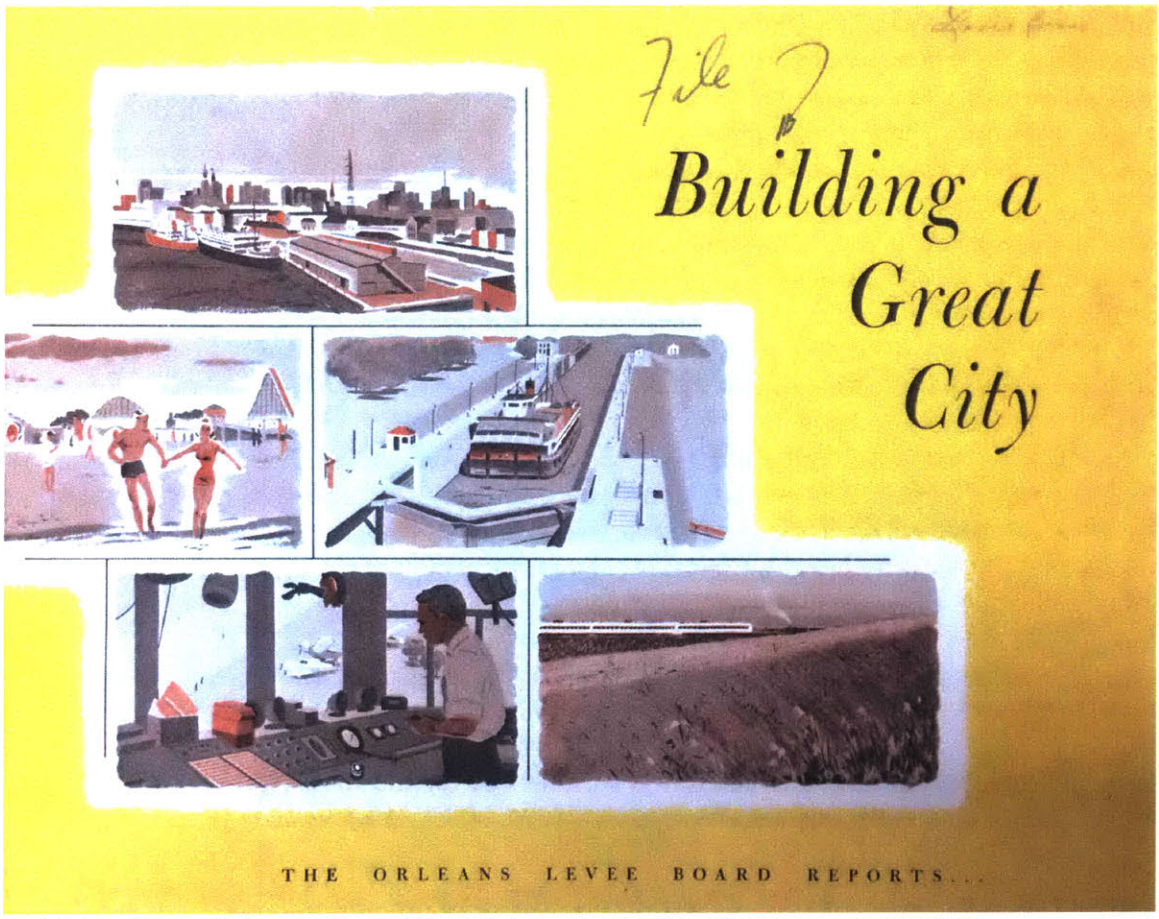


Figure 2.5. The Levee Board as city builders. Orleans Levee Board annual report (1954).

By the mid-20th century, the Orleans Levee Board, along with a handful of new public boards, such as the Dock Board and the Sewerage and Water Board, had become the key institutions advancing a particular, New Orleans-specific version of the Promethean project of infrastructural modernization. Through public investments in infrastructure, the OLB and other boards were domesticating what had been seen as a hazardous and pestilent landscape. They saw their mission extending well beyond the pragmatic concerns of infrastructure design and installation. Levees and seawalls were a means of transforming not only landscapes, but also economies and societies. By enabling the creation of new suburban neighborhoods and new connective infrastructures like the lakefront airport, the OLB became a means of replacing provincialism, precarity, and poverty with modernization, security, and prosperity.

At the same time that the OLB was presenting their infrastructural modernization work as essential to the competitive positioning and modernization of New Orleans, the Board was also defending its actions against critics who charged that the body's activities had become too disparate and disconnected from its initial mission of protecting the city against flooding. When Sam Houston Jones took over the Louisiana governorship in 1940, he commissioned a report to study the OLB's ever-expanding mission and ambitions. The resulting report complained that,

> The Orleans Levee Board, originally formed to provide Flood Protection for the Parish of Orleans, has so extended it's [sic] activities that it's [sic] levee work and Flood Protection is now only a minor part of it's [sic] responsibilities (Orleans Levee Board Study Committee 1940).

The Study Committee behind the report found a pattern of financial mismanagement in the OLB's many varied businesses and operations, including: the lakefront real estate developments, the Pontchartrain Beach amusement park, the airport, and mineral leasing on an OLB property known as the Bohemia Spillway downriver from New Orleans. In the end, the Committee recommended that "in the future, the Levee Board be restricted in it's [sic] activities for Flood Protection and to the discharge of it's [sic] present obligations" (Orleans Levee Board Study Committee 1940).

The OLB largely did not heed the recommendations of the Study Committee in the years after its report was issued. The Board continued to position itself as central to the infrastructural modernization and expansion of New Orleans into the 1950s. Responding to the criticisms voiced in the Study Committee report, the Board pointedly stated in its 1954 report that "the Levee Board is not a "grab bag." The report states that the OLB's "principal function" was "to prevent the intrusion of flood water from the Mississippi River and the Gulf of Mexico." In making the case that they were returning to this core flood protection mission, the OLB admitted that that mission had "almost become lost in the myriad of seemingly unrelated responsibilities it has been called upon to bear" (Orleans Levee Board 1954). Even as the 1954 report complains that the OLB had become "a jack of all trades," a "policeman, landscaper, lifeguard, collector of picnic trash," it also made the case for continuing its expansive activities in the suburban, industrial, and maritime expansion of the city (Orleans Levee Board 1954).

Though the development of the lakefront neighborhoods had been slowed by the Depression and the outbreak of World War II, by the early 1950s the project was largely complete and it was widely regarded as a success in terms of both flood protection and urban growth and modernization. With New Orleans' population continuing to grow in the years after the war and consumer tastes continuing to shift toward car-oriented suburban development, the OLB was eager to replicate the success of the original lakefront project on the lakefront area that stretched to the east from the Shushan Airport. A 1954 OLB report looked to the previously developed lakefront area and pronounced the project "only half finished," calling for extending a similar mode of infrastructural suburbanization along the six and a half miles of largely undeveloped shoreline to the east (Orleans Levee Board 1954). A proposal commissioned by the OLB from a local architecture and planning firm remarked that while the original lakefront project had "greatly increased the value of this property to the city and its people," "there still remains an area of the Lakefront to be developed in a similar manner" (Perez and Thompson 1950). Like the original lakefront project, this second phase included a mix of public facilities and new suburban development. (Figure 2.6)

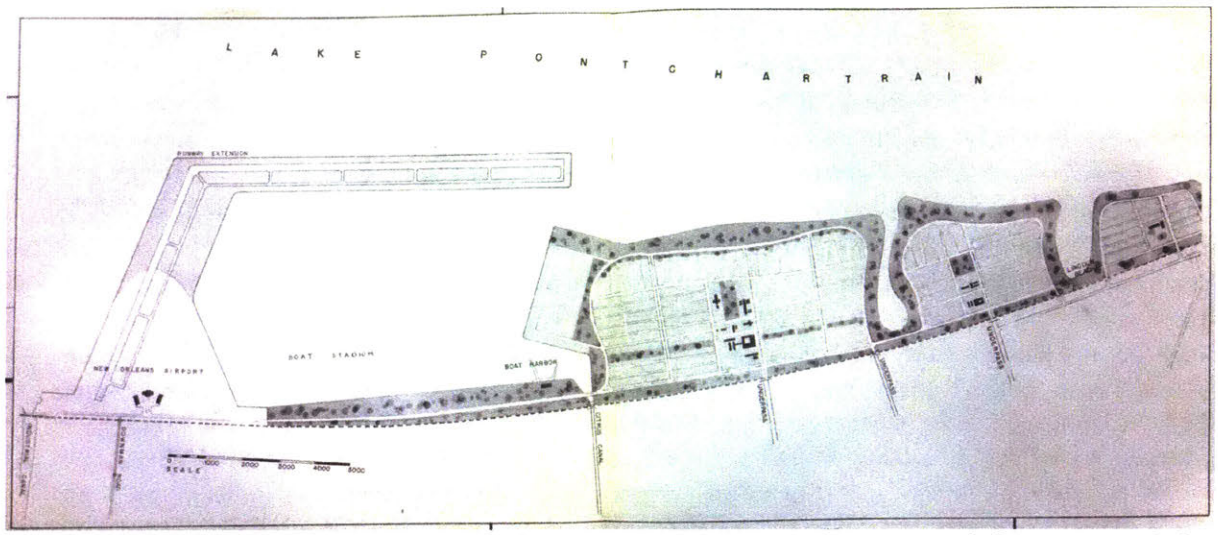


Figure 2.6. The eastern extension to the lakefront development, including proposals for an expanded airport as well as three new suburban neighborhoods, one (left) for white homeowners and two (center and right) smaller neighborhoods for African-American households. (1950)

The public components of the expanded lakefront development project included major updates and expansions to the Lakefront Airport. Just as with the initial construction, the OLB's investment in the airport facility was presented as essential to the continued growth and competitiveness of the city. The proposal called for upgrading the runways and other facilities to "the highest possible classification" and made the case that "New Orleans needs an airport of this type if it is to continue to grow and prosper" as the "Air Hub of the Americas" (Perez and Thompson 1950).The other public components of the new eastern lakefront development proposal included a new Coast Guard station, a "Boat Stadium" to host yacht races, new lakefront parks and parkways, and land for new churches, schools, and shopping centers.

While the public facilities were central to the proposal, as in the previous lakefront development, the bulk of the land to be reclaimed from the lake in the 1950 proposal was to be used for new suburban development. The proposal called for creating three distinct suburban lakefront neighborhoods, to house some 3,700 new single-family residential properties on 1,451 acres of new land. Each of the three neighborhoods would be composed of single family residential development plots on gridiron streets. In each case, these gridded neighborhoods would be surrounded by lakefront parkland and public functions would be clustered in the center of the neighborhood unit. The largest of the three neighborhoods, "residential area A" was to be reserved for white households only, while the two smaller areas B and C would be for "negro families." The racial segregation of the neighborhoods was to be reinforced by hydrological and spatial segregation as, the white neighborhood was to be "separated from Area B by a lagoon 400 feet wide and 3,300 feet long" (Perez and Thompson 1950). The two neighborhoods for African-American household were to straddle Lincoln Beach, the OLB's segregated swimming and bathing facility for New Orleans black population. The proposal argued that, together these neighborhoods and the recreational space was intended to "relieve the crowded conditions of the Negro in New Orleans" "on new land unblighted by surrounding slums and ugly commercial development" (Perez and Thompson 1950). Among the aspirations of this new reclamation project was remaking the spatial, aesthetic, and social conditions of New Orleans' African-American population by creating a separate and parallel, though somewhat lesser version of the white suburban ideal.

As in the case of the previous lakefront reclamation project, while the OLB proposals were largely of new, expanded, and modernized neighborhoods, the ostensible reason that the levee board was in the real estate development business in the first place was that this project was to provide improved flood protection for the large area of flood prone land south of the development site. The area constituted the vast minimally developed eastern frontier of the City of New Orleans. This area included the flood prone lowlands between the industrial canal on the western edge and the narrow "land bridge" reaching to the Rigolets and the Chef Menteur Pass, two waterways linking Lake Pontchartrain with Lake Borgne and the Gulf of Mexico to the south and east (Figure 2.7). As the 1950 proposal explained, "New Orleans can only expand to the east" and this proposal would "free this eastern end of the city from danger, open this area of New Orleans for residential and industrial expansion" (Perez and Thompson 1950). As in countless coastal storms before, the area had been flooded badly during a hurricane in 1947. Explaining the flood protection impacts of the extended reclamation project, the proposal went on to say,

> The completion of this future Lakefront development will provide an effective flood control measure for this eastern end of the City of New Orleans. At present, this area is protected from the lake waters by a railroad embankment, but upon completion of this project a concrete seawall of elevation plus 9.6' above mean Gulf level, will act as a safeguard against rising water caused by storms and tropical disturbances (Perez and Thompson 1950).

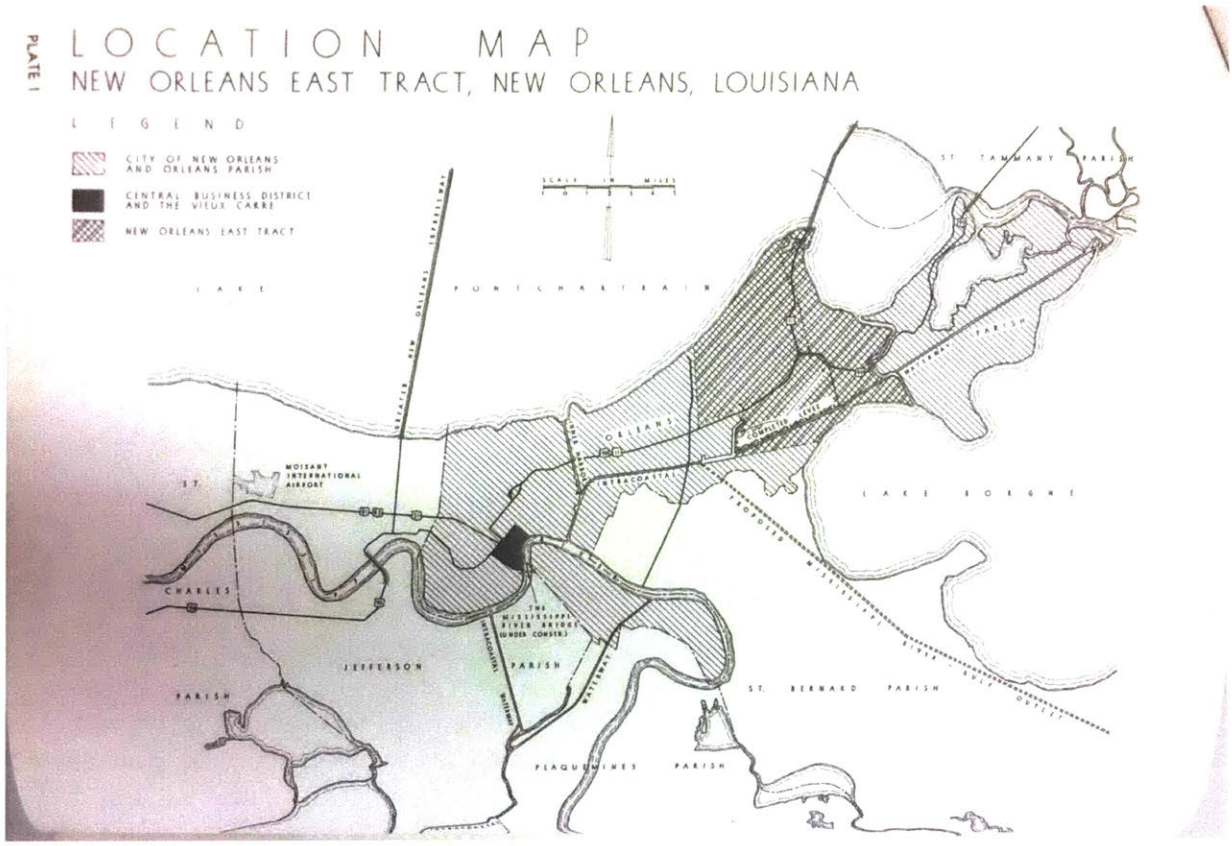


Figure 2.7. The New Orleans East tract as located in a 1959 plan by Harland Bartholomew.

A 1954 OLB report made the same case, that the development of the eastern stretch of the south shore of Lake Pontchartrain was essential to the development in "the ONLY direction we have to grow." It went further to suggest that this growth was essential to, as the title of the report suggests, "Building a Great City" saying,

> Adequate protection of this area against floods will surely be followed by new subdivision, new industrial sites, new recreational facilities to meet the public demand for more room in which to grow (Orleans Levee Board 1954).

The OLB's 1956 report, entitled "Dollars and Sense," continued to make the case that the Board's involvement in urban expansion was part of a sober and fiscally responsible approach to flood infrastructure provision. Linking flood protection, growth and development, and efficiency-minded use of "waste land," the report argued that,

> the construction of levees in a water bound area such as New Orleans is situated has an additional value - it throws up for development, both residential and industrial, large sections that otherwise would be waste land, even dangerous waste land (Orleans Levee Board 1956).

Much as the OLB presented its development of the city's lakefront airport as essential to New Orleans' modernization and connectivity in the 1920s, they made the case in the 1950s that the eastern expansion was essential if the city was to be a power center for maritime commerce. The port and shipping interests in the city had long targeted eastern New Orleans as the future site for a massive, purpose built modern port facility that they called the "Centroport." The Centroport, which was to make New Orleans into the "Rotterdam of the South," (T. Shallat 2000) was to be a major new container port connected to the Gulf of Mexico by a proposed dredged shipping channel intended to cut off the many meanders and bends in the lower river, creating a faster and more reliable route for ocean-going freighters. The OLB linked the new eastern New Orleans levee proposals to these ambitious visions for commercial and maritime development, saying that the project

> will make possible the construction of the proposed Tidewater Channel to the sea, regarded by maritime interests to be essential if the city expects to continue its growth as a center of world commerce (Orleans Levee Board 1954) (Figure 2.8).

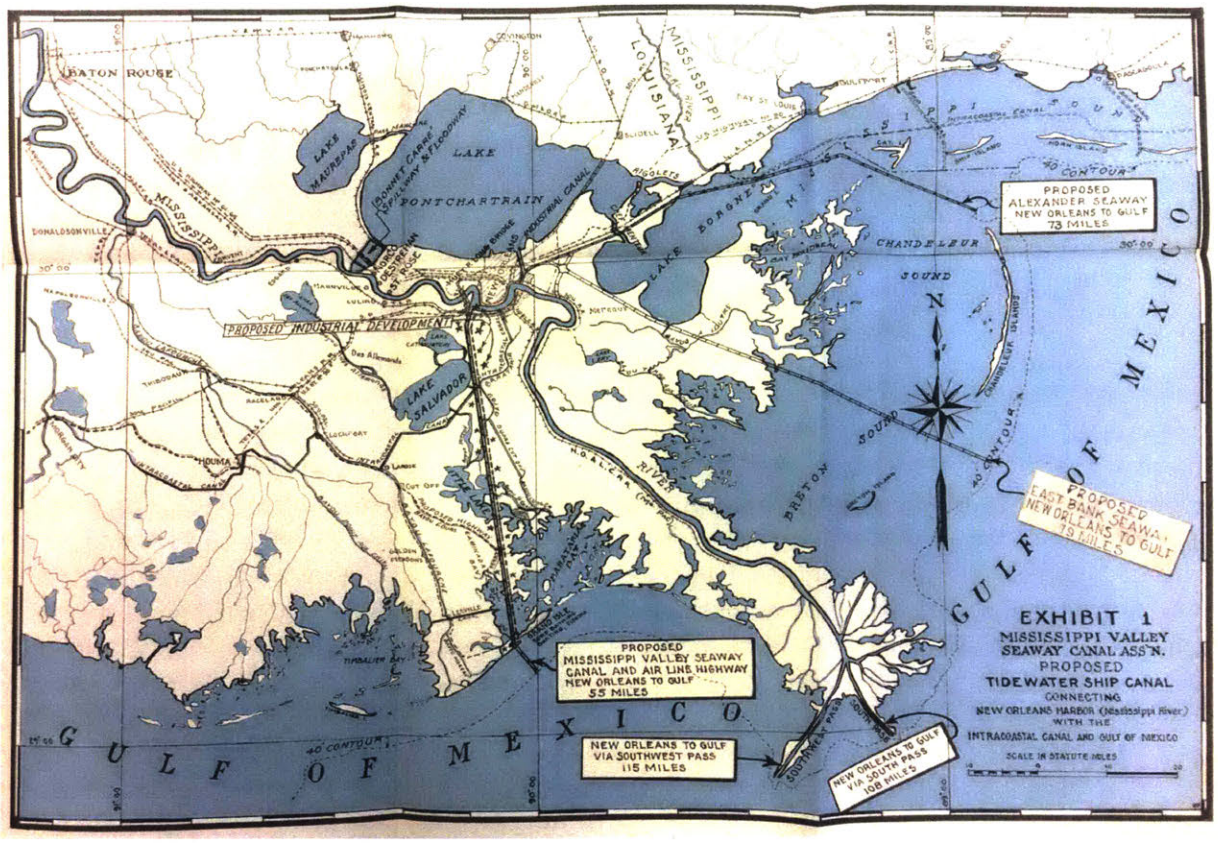


Figure 2.8. Proposals for the "Tidewater Ship Channel" and other new waterways to create more direct connections between New Orleans and the Gulf of Mexico.(The Mississippi Valley Seaway Canal Association 1949)

During mid-20th century, the OLB was at its peak as a force for the Promethean projects of infrastructural modernization in New Orleans. Levees and floodwalls were not merely a means of protecting existing settlements against inundation. They were a tool for urban expansion and modernization. Through their role in projects like the lakefront airport, the Centroport, and the Tidewater Channel, the OLB also positioned its work as central to securing and advancing New Orleans' position in a global competition among cities for industrial and shipping business. As such, the OLB made the case in 1954 that "The Orleans Levee Board is Big Business" (Orleans Levee Board 1954).

Look East: The Nationalization of New Orleans' Flood Control and a Next Competitive Suburban Expansion

While the OLB was expanding their mission to become a force in the modernization and expansion of New Orleans, the federal government was also taking on an increasingly assertive role in water management for both flood control and navigation. Following the 1927 floods and the Flood Control Act of 1928, the USACE took over the design, construction, and operation of flood defenses along the Mississippi River. The Mississippi River and Tributaries Project included reinforcement of the river's levees along with a series of spillways and control structures to allow for controlled releases in times of high water. By 1970, a USACE brochure would proclaim that the "construction of the levee system and related works for the Lower Mississippi Valley ranks among the great engineering feats of the world" (Mississippi River Commission 1970) (Figure 2.9).

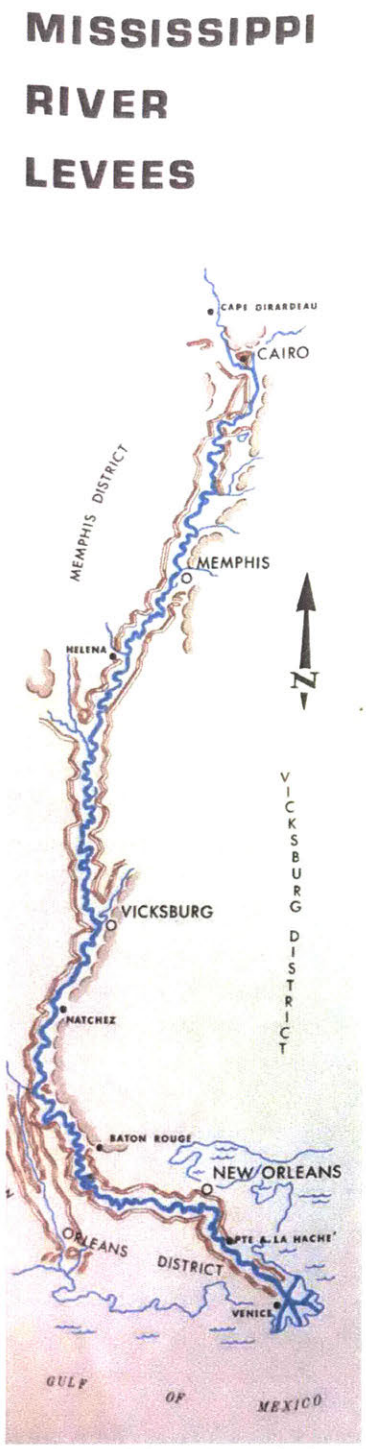


Figure 2.9. Mississippi River Levees. (Mississippi River Commission 1970)

The Corps of Engineers was also the lead institution responsible for the development of several navigation mega-projects in and around New Orleans in the mid-20th century. The Gulf Intracoastal Waterway (GIWW), a protected navigation link between Texas and Florida, was completed in 1949 and included a major new canals cut through the marshes of eastern New Orleans. The Mississippi River Gulf Outlet (MRGO), a shipping channel that took a similar approach, but a different path from the proposed Tidewater Channel, was authorized in 1956 and completed in 1961, providing a more direct route for

freight traffic between New Orleans' port facilities and the Gulf of Mexico. The GIWW and the MRGO were seen as essential components to the larger Centroport megaproject, which aimed to relocate much of New Orleans' port infrastructure from the banks of the Mississippi to newly dredged, manmade harbor facilities in eastern New Orleans.

Federal investments in flood control and navigation infrastructure projects, along with OLB plans for expanding levee protections to eastern Orleans Parish were both key parts of the long-term vision for New Orleans' growth in the mid-20th century. While the city grew steadily through much of the 20th century, the need to compete with surrounding suburban parishes and with other booming Sunbelt cities like Atlanta and Houston was a driving motivation referenced often in mid-century infrastructure and planning documents. Between 1940 and 1960, the population of Orleans Parish grew steadily from just under 500,000 to over 625,000, and increase of some 27%. Much of this new mid-century growth was in the spreading suburban neighborhoods enabled by the OLB's lakefront flood control, reclamation, and development project. While the growth in Orleans Parish was impressive, civic leaders were growing alarmed that an increasing proportion of the metropolitan population growth was occurring, not in Orleans, but in Jefferson and other surrounding parishes. New road and bridge projects were making the abundant open lands in the surrounding parishes, especially Jefferson Parish directly to the west of Orleans, accessible to suburban development. Over the same 1940 to 1960 period that Orleans Parish had grown in population by 27%, Jefferson Parish grew some 314% from just over 50,000 residents to over 200,000.

When planners from Harland Bartholomew updated New Orleans' master plan in the late 1940s and early 50s, they appealed to the need for the city to compete with other jurisdictions near and far, saying "Cities everywhere are developing new plans and revising old plans in order to adjust themselves to post-war conditions." The planners claimed that the aim of the new plan was

> guiding the city's development so that New Orleans will be equipped to successfully compete with other cities and meet the demands made on it as one of the great cities of the post-war world (Harland Bartholomew and Associates 1948).

The 1952 land use maps produced for this revised plan show the city expanding to the east with major industrial activities clustered around the planned new port infrastructure. The maps (Figure 2.10) depict low and medium-density residential development occupying a portion of the land to the north of the new port extending east from the industrial canal (Harland Bartholomew and Associates 1952).

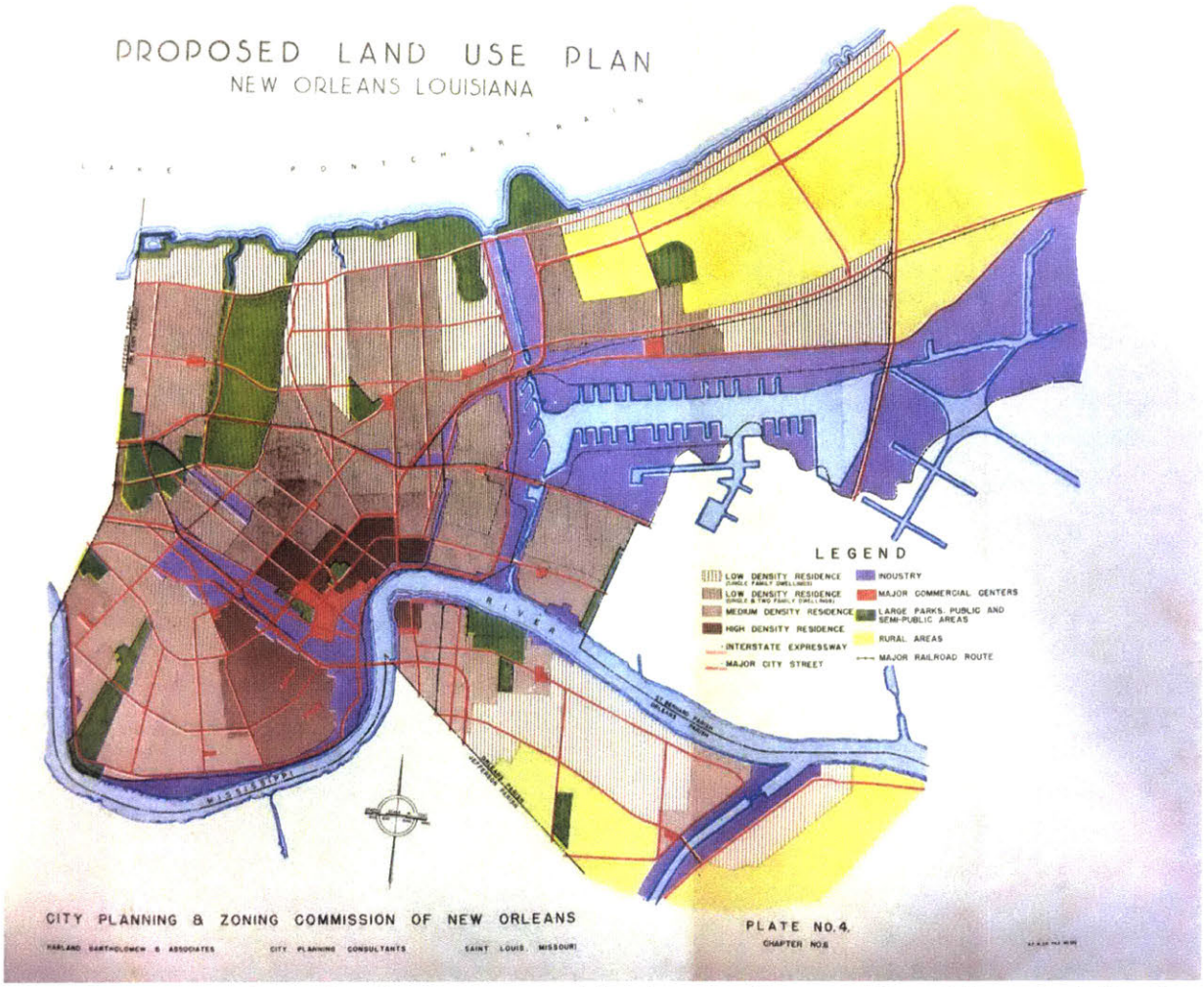


Figure 2.10. 1952 Land Use Plan showing proposed development in eastern New Orleans, including the massive new "Centroport" facilities.

As a means of enabling Orleans Parish's growth and competition with the suburban parishes and other Sunbelt cities, the OLB repeatedly promoted the idea of replicating the early 20th century lakefront development with new reclamation to the east several times over the middle decades of the 20th century. While the extended lakefront reclamation project would never be realized, public and private boosters saw the low-lying lands of eastern Orleans Parish as the only viable direction for the city to grow. Central to this vision for the eastward expansion of New Orleans was a vast landholding of some 32,000 acres in the eastern end of the parish. The land, which represented approximately one-third of the total land area of the city and parish, had remained under unified ownership since an 18th century land grant from the King of France. While regular inundation had inhibited settlement in the area over the previous two centuries, in the mid-1950s, the OLB built small levees to keep tidal flows out of the area. In 1955 Congress authorized the US Army Corps of Engineers to develop a plan for a system of levees to protect the area from hurricane-driven storm surges, though there would be no appropriation for this infrastructure for another decade (Baxter 2014).

In 1957, the area was still comprised largely of undeveloped marshlands when the owner, local real estate investor Col. R.E.E. deMontluzin, hired Harland Bartholomew to produce a "general plan" for its development. By the time the plan was completed two years later, deMontluzin had sold the property

to a group of Texas-based oilmen and real estate investors, including Lady Bird Johnson, the wife of then Senator and future Vice President and President Lyndon Johnson (Souther 2008). The new owners incorporated their business venture under the name "New Orleans East Inc." The 1959 Harland Bartholomew plan put forward an ambitious vision for a mixed-use development for the site, including a major waterfront industrial zone, a spine of commercial development along the proposed Interstate 10 expansion through the property, and a series of neighborhoods that would eventually house some 400,000 new residents, a population equivalent to roughly two-thirds of the population of New Orleans at the time (Figure 2.11).

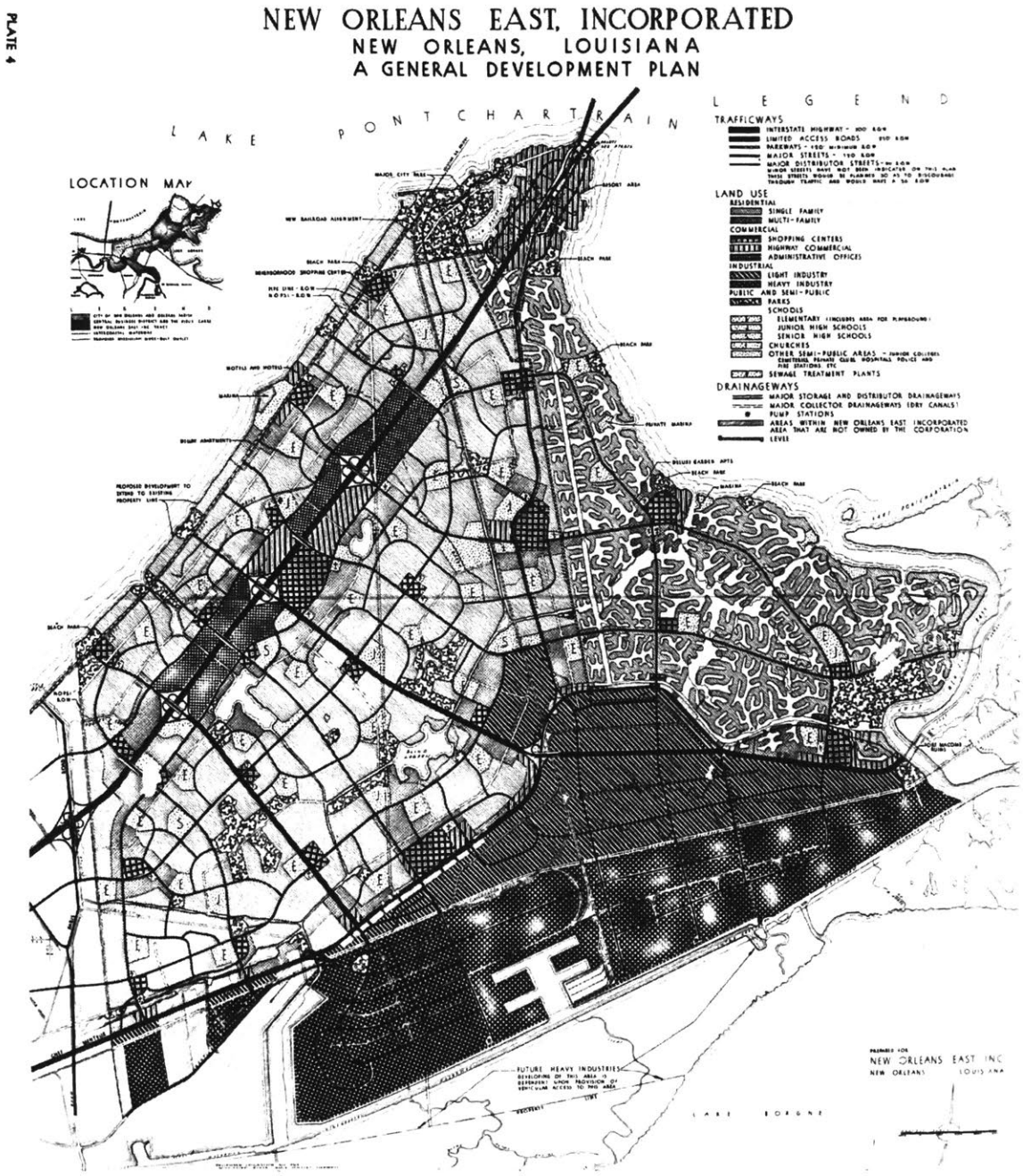


Figure 2.11. Harland Bartholomew's 1959 General Development Plan for New Orleans East, Inc.

As in the case of the lakefront development before it, the Harland Bartholomew planners saw investment in flood control and drainage infrastructure as a precondition for unlocking the development potential of eastern New Orleans. The opening passages of the 1959 plan proclaims that,

> While practically all of the land is now a swamp, a levee has been completed that will protect more than 21,500 acres from tide and flood waters. The elevation of the area is similar to that in most of New Orleans and with the construction of canals and installation of pumps - it can readily be made available for urban development (Harland Bartholomew and Associates 1959).

The plan struck the familiar cords, appealing to the proud history, grand ambitions, and competitive spirit of New Orleans' civic leaders, linking the drainage of eastern New Orleans to "the complete realization of [the city's] destiny," saying,

> When the last remaining undrained acreage of the city, the area comprising the New Orleans East tract, is dry, unlimited growth possibilities will result. New Orleans will have realized the dream of its founders two hundred years later.

For the project's boosters, the leveeing, drainage, and development of New Orleans East represented a realization of the city's destiny and an opportunity to again mobilize the alchemical power of flood control to enable the growth and modernization of New Orleans.

The 1959 New Orleans East (NOE) plan, like Harland Bartholomew's 1928 plan for the lakefront reclamation area, applied contemporary planning principles to the rational and efficient development of the site. In keeping with the planning orthodoxy of the time, the elementary-school centered "neighborhood unit" was the essential module around which the scheme was built. The NOE plan included 33 distinct, school-centered neighborhood units.

Where the lakefront development had largely eschewed any substantive engagement with water and drainage issues, the New Orleans East plan includes somewhat more attention to the commercial and experiential potential of water infrastructure. While the 1920s planners had rejected the idea of incorporating lagoons and lakes into the lakefront neighborhoods as "inappropriately" "accentuat[ing] the lowland idea," in the NOE plan, they called for a "system of canals, a few lagoons and pumping stations [which] should provide ample drainage and afford attractive features for residential development" (Harland Bartholomew and Associates 1959). To further accentuate this merging of functional and aesthetic potential in drainage infrastructure, the proposal includes a page of sketches from the landscape architecture firm, Sasaki, Walker, and Associates (Figure 2.12).

Figure 2.12. "Sketches of Design Treatment of Lagoons and Canals in New Orleans East Tract." Sasaki Walker and Associates, as included in the 1959 Harland Bartholomew Plan.

In another pragmatic nod to the role of water in shaping the form of the proposal, the 1959 plan calls for a significant portion of the 8,250 acres of the property that lay outside the newly constructed levees to be developed as so-called "Florida-Type" waterfront residential lots. Through dredging and filling, they proposed to create a network of canals, onto which thousands of new residential lots would face, transforming the marshy flood prone character of the land from an impediment into a lifestyle and sales asset. A New Orleans East Inc. executive proclaimed this canal-based development a "merger of the historic… charms of Venice, with one aspect of the South – the old tidewater plantations" (Souther 2008).

The 1959 NOE plan represents an evolution in the treatment of flooding and drainage infrastructure in New Orleans' planning. Where previous generations had sought to banish water entirely, this plan introduced the idea that infrastructural landscapes might contribute to the aesthetic experience of the

project. However, the scheme stopped short of embracing the natural hydrological systems and processes as a hazard mitigation strategy as later generations would propose.

Unlike the lakefront development, which had been driven by the OLB, a public entity, the proposals for the development of New Orleans East were largely controlled by private real estate development interests. Nonetheless, public agencies, such as the OLB, CPZC, the SWB, and New Orleans Public Services Inc. (NOPSI), the public utility and transit provider in the city, were essential to the vision of eastward expansion. As discussed above, the newly expanded levees in the area were a precondition for the development of the proposal. Revised zoning and land use maps produced in 1957 and 1959 largely reflected the desires of the NOE Inc. development team as expressed in the Harland Bartholomew plan. NOPSI took an active role in promoting the residential and industrial expansion in eastern New Orleans. Development in New Orleans East got underway in the early 1960s. The area saw substantial industrial projects, including the NASA Michoud assembly plant in a 40-acre area adjacent to the NOE Inc. parcel. The NASA Michoud plant built rockets to power spacecraft. The project was initiated in 1961 and employed some 10,000 people by 1964. A 1963 pro-development pamphlet produced by NOPSI, cheered new development in the area, saying, "Don't' trip over any grade stakes – they're everywhere." (New Orleans Public Service Incorporated 1963) A 1970 NOPSI advertisement urged people to "Join the PARADE to BETTER LIVING in a new *Planned* city... combining Suburban living with City convenience" (Souther 2008).

The pace of development in New Orleans East was substantially slowed after the area was inundated by floodwaters during Hurricane Betsy in September of 1965. While Betsy decelerated development in the area, it also acted as a spur for yet another expansion in the role of the federal government in flood protection in New Orleans. The Flood Control Act of 1965, passed in the aftermath of Betsy, appropriated the funds for the hurricane protection levees authorized ten years before. The Act made the U.S. Army Corps of Engineers responsible for building the levees to protect New Orleans from flooding, not just from the Mississippi River, but also from storm surges associated with hurricanes. The Corps drafted the Lake Pontchartrain and Vicinity Hurricane Protection Project (LPVHPP), an ambitious program of infrastructure investments intended to envelop nearly all of Orleans Parish in a system of protections engineered to withstand a 100-year storm. The initial LPVHPP proposal included new and strengthened storm protection levees along several canals, lakeshores, and marshes in the New Orleans metropolitan area, including virtually all of New Orleans East. It also called for three major closure structures to control the flow of water in and out of Lake Pontchartrain. These closures, at the lakefront entrance of the Industrial Canal, Chef Menteur Pass, and the Rigolets, would have included navigation locks and storm barriers that could be closed to prevent storm waters from surging into the lake from the Gulf (Figure 2.13). This plan became known as the "low-level barrier plan," because the Corps argued that by including the closure structures at the entrances to Lake Pontchartrain, the plan would need only low levees. This plan was later debated alongside the so-called "high level plan," which included raised and strengthened levees but did not include the closure structures.

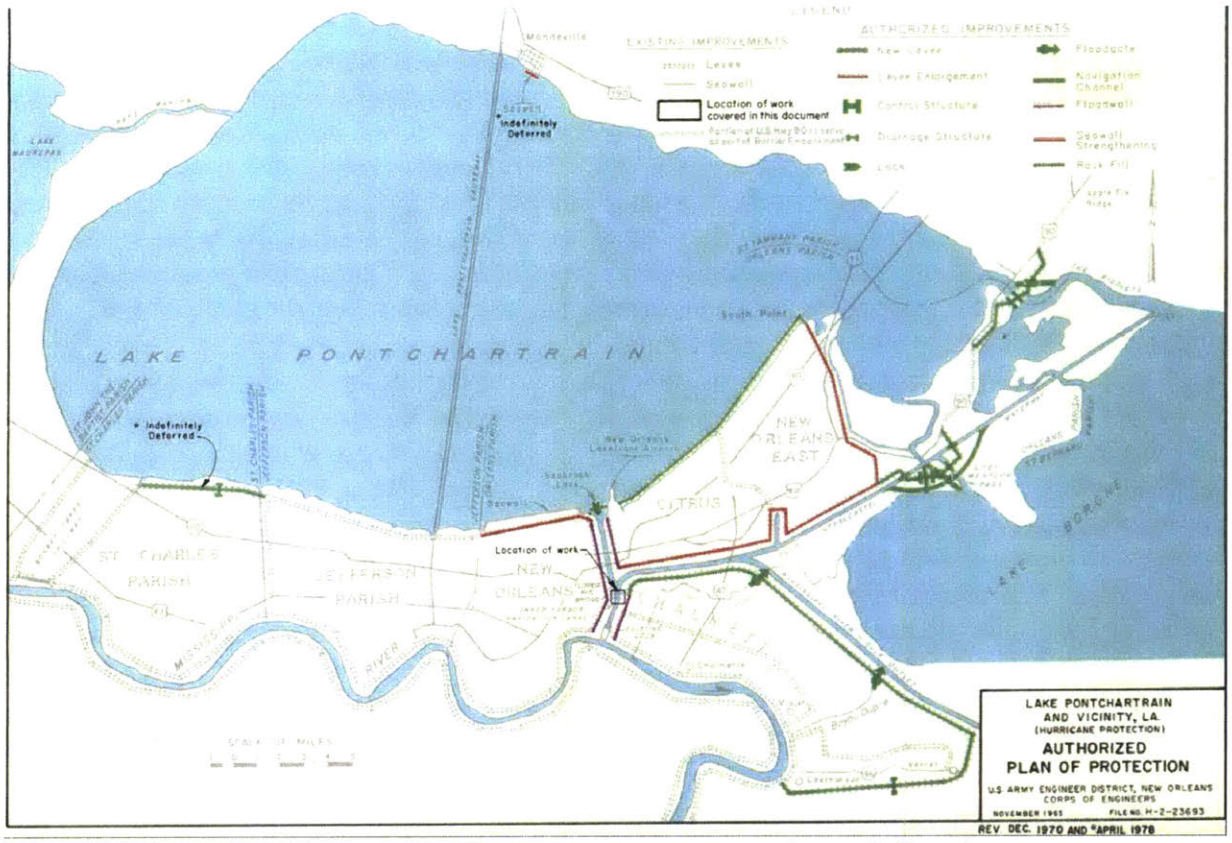


Figure 2.13. Lake Pontchartrain and Vicinity Hurricane Protection Plan, including closure structures between Lake Borgne and Lake Pontchartrain. (US Army Corps of Engineers District, New Orleans 1970)

The LPVHPP continued the pattern of public infrastructure investments fueling private real estate speculation. By some estimates, the passage of the 1965 Flood Control Act and its promise of flood protection, increased property values in New Orleans East from $200 per acre to $15,000 per acre (Sothern 2007). This commitment of federal funds for improved flood protection was paired with increasing local investment in drainage infrastructure. In 1966 New Orleans voters approved $3 million in new taxes for the Sewerage and Water Board. In 1967, the Board approved a 5-year $28 million drainage plan which included new pump stations and canals in eastern New Orleans (Baxter 2014).

Even as the USACE took on an increasingly prominent role in levee funding, design, and construction, the Orleans Levee Board continued to assert its dual role, simultaneously presenting itself as a driver of growth, modernization, and competitiveness and as the sober and strong protector of the city. A 1965 public mailer to the citizens of Orleans Parish from the Board accentuated this second component, saying "your Orleans Levee Board" was "watching over you and your family" (Orleans Levee Board 1965). The report was illustrated with a drawing of a burly giant holding a piece of heavy equipment in one hand and a sand bag in another, protecting three smaller figures, a prosperous and secure family (Figure 2.14). The levee board was so enamored of this symbol that they used the image of the giant as a background in the Board's stationary in the following years.

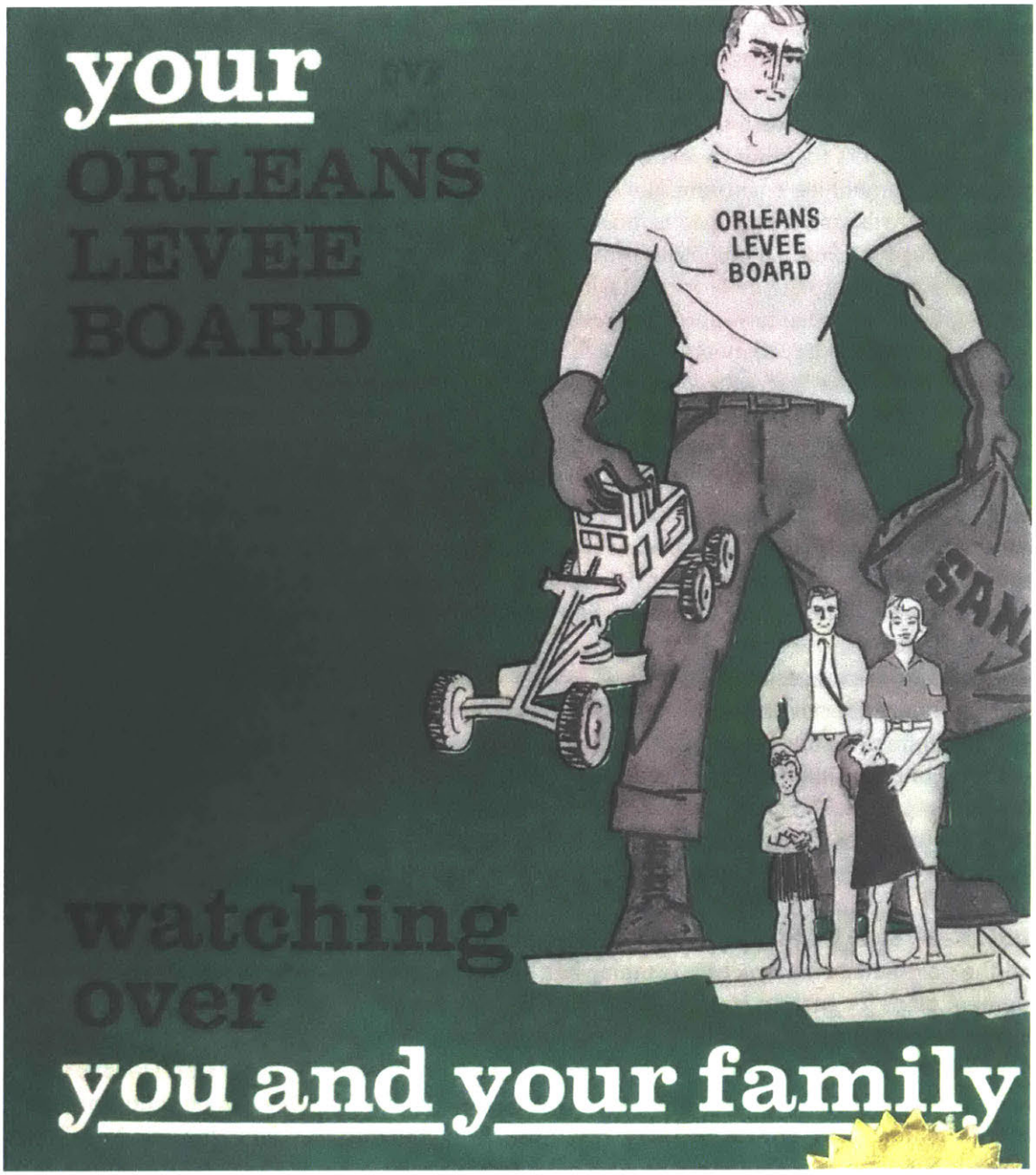


Figure 14. The Promethean Protector. Orleans Levee Board mailer, 1965.

With the development of eastern New Orleans, the federal government joined local public agencies in becoming a major force enabling urban expansion. The industrial development in the area was spurred both by the NASA Michoud plant and by major investments in navigation infrastructure to serve the area. The major federal investment in Interstate 10, which runs from west to east through the entire area, was regularly cited as an essential component of making development of New Orleans East viable, both allowing easy access to the core of the city and creating of a new spine of retail and office development along the new highway.

The Environmental Challenge to the Promethean Levee Modernization Project

With the LPVHPP, the US Army Corps of Engineers' flood control mandate was decisively separated from the interests of interstate commerce and navigation. However, just as coordinated federal and local investments were spurring eastward expansion in New Orleans, other efforts brought federal regulations and local actors together to restrain this move towards federally funded infrastructural modernization. The burgeoning environmental movement in the US furnished both new legal tools and strengthened popular resistance to previous models of urban growth. The National Environmental Policy Act (NEPA) was passed in 1969. Among other provisions, NEPA required that federally funded projects, including USACE levees, complete environmental impact studies (EIS). In 1972, congress passed the Clean Water Act, which included new permitting requirements for dredging and filling wetland areas, calling into question the viability of much of the existing New Orleans East development plan, including the massive areas of "Florida-like" waterfront development in the areas outside of levee protection.

When the Corps issued the EIS for the LPVHPP's low-level barrier plan, with its storm surge closure structures at the entrances to Lake Pontchartrain, newly energized local environmental organizations rallied against the plan. A group called Save Our Wetlands (SOWL) filed suit to stop the barrier plan, arguing that the EIS was insufficient. The group argued that the barriers would harms the ecosystems of the lakes and surrounding wetlands and that the plan was largely an attempt to enable more coastal real estate development. A lawyer for the group called the plan "pure pork barrel." In support of the suit, the Orleans Audubon Society argued that they "could only conclude the Corps favors enrichment of a few landowners at the expense of us taxpayers" (Baxter 2014). The lawsuits brought by local environmental groups under the new federal laws succeeded in slowing and altering the course of federally-enabled infrastructural modernization in eastern New Orleans. In December of 1977, a federal judge issued an injunction that halted work on much of the LPVHPP's low level barrier plan until a new revised EIS was completed. The Corps eventually abandoned the plans for the closure structures and, after issuing a re-evaluation study in 1984, settled on the "high level plan," which called for larger levees and flood walls to compensate for the lack of storm surge barriers into the lake.

Pontchartrain New Town: Reuniting Flood Protection and Spatial Planning under Federal Control

Throughout the post-Betsy infrastructure planning and legal wrangling, other factors continued to shape the development plans for eastern New Orleans. In 1970, congress passed the Urban Growth and New Community Development Act to provide federal funding through the Department of Housing and Urban Development (HUD) for so-called "Title VII New Towns." To access these HUD funds, New Orleans East Inc. partnered with the City of New Orleans' newly formed New Community Development Corporation to propose an ambitious plan for an 8,400-acre mixed-use development called Pontchartrain New Town In Town (PNT).

The PNT plan, as set out in the project's multi-volume proposal studies, was ambitious and innovative on a number of fronts. In a shift from the racial and land use segregation of the 1959 Harland Bartholomew plan, the PNT plan sought to recreate the social diversity of the city and advocated for a diversity of densities and housing and settlement types based on studies of local urban and architectural precedents. The PNT plan also put forward a new vision for how urban development in the region should interact with water. Where the 1959 Harland Bartholomew plan, with its sketches for water-based landscape amenities from Sasaki, had signaled that drainage infrastructure might "afford attractive features for residential development" (Harland Bartholomew and Associates 1959), the PNT plan made water and drainage the central organizing principle of their "ecological planning approach" (New Orleans East Inc. 1972). The PNT plan was led by the Philadelphia-based landscape and planning firm, Wallace, McHarg, Roberts, and Todd (WMRT). WMRT had been started by landscape architect, Ian

McHarg, the author of *Design with Nature,* the 1969 book which laid out a new method of landscape planning based on deep study of underlying geological and ecological characteristics of a site. As in the Woodlands, another WMRT-led plan for a Title VII new town outside of Houston, hydrology, soil conditions, and ecology were the primary drivers of the site strategy for the PNT proposal. Rather than inserting lagoons as an amenity in residential neighborhoods as the 1959 Harland Bartholomew/Sasaki plan had done, the WMRT proposal mapped existing biophysical features of the site to "determine where not to build, where to build and how to build to best accommodate man and his needs to the natural environment" (New Orleans East Inc. 1972). The proposal called for a complex pattern of cutting and filling to create mixed-use developments on elevated lands organized around a network of interconnected waterways. Development was targeted "on those areas already degraded" by previous drainage projects. The extensive network of new and restored wetlands was to maximize the ecological health of waterways and lands both inside and outside the protective levees in the area (Figure 2.15).

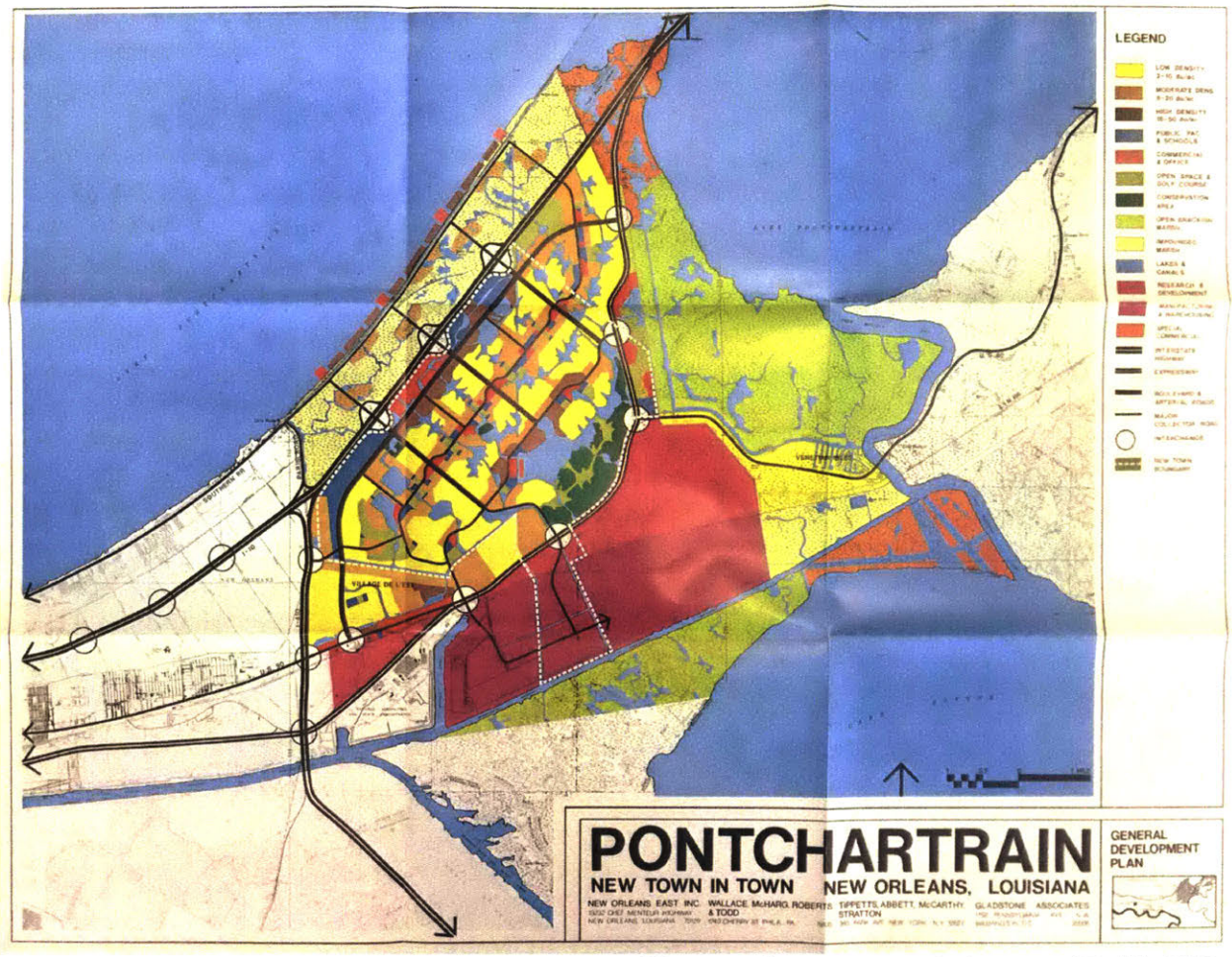


Figure 2.15. Pontchartrain New Town In Town proposal from Wallace, McHarg, Roberts and Todd, 1972.

The WMRT proposal for PNT was driven by a new paradigm of water management to "respond and contribute to the natural environment of the site and the surrounding area and provide extensive man-nature interaction" (New Orleans East Inc. 1972). Nonetheless, the project still relied on conventional flood protection levees. After the submission of the initial proposal, HUD informed the team that they would not be eligible for any federal funding as long as residential development areas were vulnerable to 100-year storm conditions (Kaiser Engineers 1973). While both the OLB and the USACE were in the

midst of building new levee protections intended to protect the area, they were not scheduled to be in place in time to satisfy HUD's requirements. The timeline for the area's hurricane protection levees would become further delayed in the lawsuits brought by SOWL against the Corps' lake closure structures.

In the end, the PNT proposal failed to receive the federal loan guarantee and other funding requested from HUD before the entire new town program was scrapped in 1975. After the failure of the public-private new town proposal, New Orleans East Inc. again rebranded and re-launched their project. A 1975 glossy brochure from the company announced the new project, saying "Look east to Orlandia, the Newest New Orleans." The new, wholly private proposal, dispensed with the McHargian "ecological planning approach" and proclaimed Orlandia a "practical vision"; "practical in that the need, the economics, the know-how and the desire are there. The land is there, the expressway is there, the employment base is there, and the market beckons" and "a vision, of the best of America in its third century of liberty" (Orlandia 1975). Gone are the ambitious visions for natural drainage and site planning. In their place, the brochure simply promised that

> complete [levee] enclosure is scheduled for 1977 of 20,000 acres within Orlandia based on 100 year flood criteria, through a series of Levee Board and U.S. Engineers projects now under way or recently completed. (Orlandia 1975)

Gone are WMRT's promises of "extensive man-nature interaction" enabled by a complex interweaving of water and urban development. The Orlandia brochure simply describes a "network of drainage works" and SWB pumping stations.

Even with its much-reduced ambitions, the Orlandia proposal still languished. While the legal wrangling and slow pace of the post-Betsy flood protections brought uncertainty, it was macroeconomic and demographic factors that ultimately doomed the project. Though promotional materials from the early 1980s proclaimed "East New Orleans" as the "last frontier" for urban development in New Orleans, the demographic and economic imperative for growth had largely collapsed (Figure 2.16). Between 1960, a year after the formation of New Orleans Inc., and 1990, the population of Orleans Parish had shrunk by over 20%. A dramatic drop in oil prices in the mid-1980s hampered industrial and economic growth in New Orleans, caused a downturn in the local real estate markets, and bankrupted the Texas oilmen who were the primary investors behind New Orleans East Inc. In 1985, after realizing only fragments of the ambitious vision for New Orleans East, most of the land owned by the bankrupt company was sold to the federal government and converted into the Bayou Sauvage National Wildlife Refuge, the largest refuge within any American city.

Figure 2.16. East New Orleans: The Last Frontier. 1983.

Conclusions

From the earliest days of its founding, the form, growth, and character of New Orleans have been defined by the city's relationship to the rivers, lakes, marshes, and swamps that surround it. The lower Mississippi delta landscape is naturally inundated regularly, both by the turbid Mississippi River waters and by salt and brackish waters pushed by tides and coastal storms from the Gulf of Mexico. Through the combined powers of engineering technology and the regulation of space, leaders in New Orleans have iteratively reshaped settlements and landscapes to cope with the threat of flooding. While this process of settlement adaptation and landscape alteration began with the earliest European colonial outpost in the early 18th century, it was during the period from the late 19th to the mid 20th century, that New Orleans' leaders most aggressively embraced the promise of infrastructural modernization, mobilizing planning, spatial governance, and technology to protect existing settlements and enable expansion. By the later decades of the 20th century, criticisms against interventionist infrastructural modernization were mounting. These critiques, aligned with broader shifts, including neoliberal retrenchment in state infrastructure investment and demographic and economic declines in the New Orleans region, triggered the end of the era of levee-led growth.

For the purposes of understanding New Orleans' contemporary urbanization patterns and their relationship to emerging proposals for contemporary water planning projects, there are three primary themes to be gleaned from this rise and fall of dry city infrastructural modernization: 1) spatial planning has been integrally intertwined with drainage and flood protection since before the first institutionalized planning efforts in New Orleans; 2) the embrace of dry city infrastructural modernization as a means of urban growth was an uneven, discontinuous, and contested process; and 3) the costs and benefits of infrastructural modernization were deeply uneven in their distribution.

Hydrocracy and Planning in New Orleans' Infrastructural Modernization

In New Orleans, levees and other technologies of infrastructural modernization were used from the earliest days of the city's settlement. The modern hydraulic bureaucracies of the Sewerage and Water Board and the Levee Board were precedents and models for New Orleans' earliest modern city planning institutions. As such, in many instances, these water bureaucracies enjoyed a sort of spatial and institutional primacy, taking the lead in ambitious land reclamation projects that promised to enable growth, prosperity, modernization, and competitiveness. New Orleans' leaders pursued territorial, economic, and demographic growth unabashedly and viewed the technologies of infrastructural modernization as core tools for mobilizing public resources to enable and shape that growth.

While the low and swampy terrain surrounding New Orleans restrained the city's growth, it also gave public institutions more control over growth than would be the case in cities surrounded by lands more hospitable to small-scale private development. The ability to issue bonds and levee taxes to raise funds was central to the capacity of New Orleans' hydrocracies to work their alchemical magic of land creation. As was the capacity of the Levee Board to negotiate with state government for the right to reclaim state land on the foreshore of Lake Pontchartrain. Because the Levee Board had the legal and technical capacity to make new land, they were able to exercise a degree of control over the planning and development of that land, particularly in the case of the early 20th century reclamation of the southern shore of Lake Pontchartrain. In the mid-20th century development of eastern New Orleans, the Levee Board played a less dominant planning role, with private landowners and developers increasingly shaping spatial planning. At the same time, the federal government, in the institution of the US Army Corps of Engineers, came to play an increasingly important role in the flood protection-based growth of the city. With this increasing federal role, levee discourses in New Orleans shifted from an emphasis on growth, modernization, and competitiveness to a focus on security and the protection of life and property. The Title VII New Town proposals of the early 1970s offered a brief glimmer of hope for a reuniting of water management and spatial planning both with the strong guiding hand of the federal government. However, with the abandonment of the federal role in new town development, ambitions for reimagining the relationship between water and urbanization in the region also largely disappeared.

The Uneven, Discontinuous, and Contested Infrastructural Modernization

While the history of New Orleans' urban growth in inextricably tied to the city's ambitious projects for flood protection and drainage, it is also crucial to note that the process of infrastructural modernization was not smooth, linear, and continuous. Both at the broader scale of the Mississippi Valley and at the scale of the city of New Orleans, the process was episodic, crisis-driven, and, at times, contested. The national planning for flood infrastructure on the Mississippi River in the mid 19th century was a deeply disputed process in which the Humphreys and Abbot 'levees-only' approach won out over Ellet's vision for a more comprehensive vision of landscape integrated water management. Corthell's late 19th century account of the long-term dangers of leveeing the river came to pass even earlier than he predicted, and elements of the comprehensive approach were adopted early in the 20th century. As later chapters will discuss, many of the contemporary planning efforts now underway in the lower Mississippi

delta can be seen as addressing the long-term problems that Corthell predicted would come from severing the connection between the river and its delta with continuous levees.

The march of levee-led growth in New Orleans was not a steady and continuous process. Rather, spasms of planning and infrastructure development proceeded based on a combination of linked factors, including: dramatic flooding events (e.g., Great Flood of 1927 and Hurricane Betsy); technological advancements (e.g., the Wood Screw Pump and advancements in earthmoving); and institutional shifts (e.g., the creation of local planning and infrastructure bureaucracies and the expansion of the federal role in flood protection).

Early planning efforts in New Orleans operated with a highly circumscribed vision for the relationship between spatial planning and water management. The Harland Bartholomew planners who conducted the city's first master plan and zoning ordinance, and who created the 1920s plan for the lakefront development project largely eschewed water management, choosing to treat the newly created land as a blank screen onto which they could project a vision in keeping with the planning fashions of the day. Just thirty years later, the same firm signaled a shift in the treatment of water infrastructure, including sketches for drainage landscapes as urban amenities. The Wallace, McHarg, Roberts, and Todd proposal from the early 1970s for the Pontchartrain New Town development pushed much further, treating hydrology and ecology as the fundamental organizing features around which the town would be planned, while seeking to use the new town development as a means to repair the ecological damage done by previous generations of water infrastructure. While these proposals were not realized, the WMRT 'ecological planning' approach signaled a shift away from aggressive infrastructural modernization and previewed the 'design with nature' and 'living with water' approaches that are increasingly dominant in contemporary water planning in New Orleans, Dhaka, and beyond.

Uneven Protections: Racialized Distributions of Costs and Benefits

While the use of flood protection and drainage infrastructure to enable urban growth and modernization in New Orleans clearly aligns with Kaika's description of the Promethean project of infrastructural modernization, it is more debatable to what extent dry city infrastructural modernization can be seen as "comprehensive" in Graham and Marvin's terms. For Graham and Marvin, "comprehensive" infrastructures were the norm before the late 20th century era of "splintering," in which networked infrastructures became more fragmented and uneven (S. Graham and Marvin 2001). As several critics have demonstrated, urban infrastructure provision has always been uneven and fragmented (McFarlane 2008). Ring levees like those built in New Orleans do provide encompassing security that nominally protects all people and property inside the polder. Levee boosters like those on the Orleans Levee Board presented levees as furnishing a universal benefit to the people of New Orleans. Nonetheless, the costs and benefits of New Orleans' levees are clearly distributed radically unevenly. While the lakefront development project of the 1920s created a nominally comprehensive protection infrastructure for lake flooding, the topographic distinctions between the newly reclaimed neighborhoods and lower lying areas to the south created deeply uneven vulnerabilities that were on stark display following the Hurricane Katrina levee breaches. Similarly, the 1927 intentional breaching of the Mississippi River levees in St. Bernard Parish below New Orleans highlighted another dimension in which the protections afforded by levees can produce highly uneven risks. In this case, it was rural residents who were forced to pay the price of protecting urban settlements in New Orleans when the levees were blown to relieve pressure on the city's levees.

While New Orleans' urban form and development trajectory have been deeply shaped by the city's topographic and hydrological situation, the story of the city's embrace and growing skepticism of

aggressive dry city infrastructural modernization illustrates the extent to which distinct choices, framed by changes in institutions and technologies, have set New Orleans on a particular course. Particular forms of infrastructure-dependent growth and modernization mobilized through new institutions and technologies and motivated by episodes of crisis have radically altered the city region's hydrology.

As the next chapter shows, the infrastructural modernization in Dhaka shares many patterns with the process in New Orleans. In Dhaka, as in New Orleans dry city infrastructural modernization saw a dramatic rise over the course of the 20th century. Similarly, by the end of the 20th century, there was mounting resistance to the aggressive interventionism of levee-and-pump based urbanization in Dhaka. In both cities the pattern was shaped by the relationships between water engineering bureaucracies and emerging institutions of city planning. In both, the process was uneven, episodic, and contested. And in both Dhaka and New Orleans, there are meaningful and troubling patterns of uneven distributions of costs and benefits from infrastructural modernization. However, as striking as some of the similarities may be, seen in relation to New Orleans, Dhaka's infrastructural modernization also illustrates some significant departures rooted in the historically-contingent and path-dependent patterns of urbanization.

CHAPTER 3
'Venice of the East' to 'Ambassadors with Bulldozers': Dry City Infrastructural Modernization in Dhaka

Chapter Summary

Dhaka, like New Orleans, sits within a major continental river delta. Like New Orleans, the origins and historical growth in Bangladesh's booming capital city have been substantially shaped by the changing relationship between urban settlement and water. This chapter introduces the historical evolution of water management and spatial planning in Dhaka.

Though Dhaka's urbanization has long been influenced by the scarcity of flood-safe land, for much of its history, the city did not have structural flood protections like the encompassing levees in New Orleans. Until the late 20th century, the city relied on landscape integrated and land use-based approaches to flood mitigation, including preferential urbanization on flood safe land and distributed systems of canals, ponds, and tanks for retaining and draining water passively. In many instances, these earlier distributed and open flood mitigation methods previewed strategies that have gained popularity in the recent movement towards 'resilient' or 'adaptive' urbanism. It was not until the late 20th century, after the city had been through several periods of urbanization, that dry city infrastructures like levees and pumps were built in Dhaka.

Beginning in the late 1960s and early 1970s, government officials and development consultants in Bangladesh embraced a vision of modernization that placed water infrastructure at the core of a program of wholesale economic, social, and spatial transformation of the post-colonial state. These proposals were advanced by so-called "Ambassadors with Bulldozers," public and private sector engineering experts from countries like the USA, Japan, and the Netherlands. The new post-colonial governments of East Pakistan and later Bangladesh, eager for visible progress and legitimization, took up the mantle of state-led water infrastructural modernization. After consecutive years of heavy flooding in the late 1980s, Bangladesh's leaders, enabled by international consultants, donors, and lenders, instituted Dhaka's first system of flood protection embankments and pumps. As in New Orleans, levee boosters in Dhaka promised that investments in flood protection would bring transformative socio-spatial change. Whereas New Orleans' levees were expected to boost growth, competitiveness, and modernity, the politicians and consultants behind Dhaka's embankments saw these structures as a means of taming the chaotic growth of the city. Over subsequent proposals, levee boosters in Dhaka argued that the structures would provide a range of additional benefits, including environmental and sanitation improvements, economic growth, poverty alleviation, and traffic alleviation.

Plans developed since the embankments were built in the 1990s have embraced dry city infrastructures. Levee boosters in the city have argued that levees will lead to more orderly spatial development in the city. However, they have also recognized that non-structural strategies, such as land use regulation and building controls, are essential to the success of structural protections.

Even as Dhaka's embankments were being constructed, there was mounting resistance, in Bangladesh and abroad, to this aggressive infrastructural interventionism. Infrastructural failures and mounting evidence of unintended social and environmental impacts drove critiques of infrastructural modernization in Dhaka and in the wider delta. As in New Orleans, these critiques, along with broader political shifts towards a shrinking role for state investment have led to reductions in major flood control projects in Dhaka even as the city has continued to grow rapidly.

Introduction: Settlement on the unsettled terrain of the eastern Bengal delta

The national territory of Bangladesh is largely comprised of the shifting landscape of the eastern Bengal delta. Some eighty percent of the country is defined as river delta, dominated by the ever-changing channels, floodplains, and distributary networks of three 'mighty rivers': the Ganges/Padma, the Brahmaputra/Jamuna, and the Meghna. The capital city of Dhaka sits near the geographic center of Bangladesh, just to the southeast of the current junction of the Jamuna and the Padma and just to the northwest of where these combined rivers join the Meghna (Figure 3.1). Amidst the flat and low-lying landscape, Dhaka sits at the south-facing point of a triangular formation of relatively high and stable land characterized by geologists by its red laterite clay soils (Karim 1964). A British colonial administrator in the 1870s described the region's deltaic topography saying,

> The country about Dacca is strictly alluvial, and consists of vast plains, raised but slightly above the level of the rivers, which during the rains extend in many parts far and wide over the lower lying tracts of rich alluvial soil. (Hutcheson 1872)

It was this rich alluvial soil and the rivers that deposit it that have made the eastern Bengal Delta attractive for agricultural settlement, colonial appropriation, and strategic military emplacements. The tension between the natural and strategic advantages of the landscape and the delta's forbidding climate, hydrology, and rebellious indigenous populations, led the Mughal colonists to refer to the eastern delta as a "hell full of bread" (S. U. Ahmed 1986), echoing Peirce Lewis' ambivalent description of New Orleans as "the impossible but inevitable city" (P. F. Lewis 2003b).

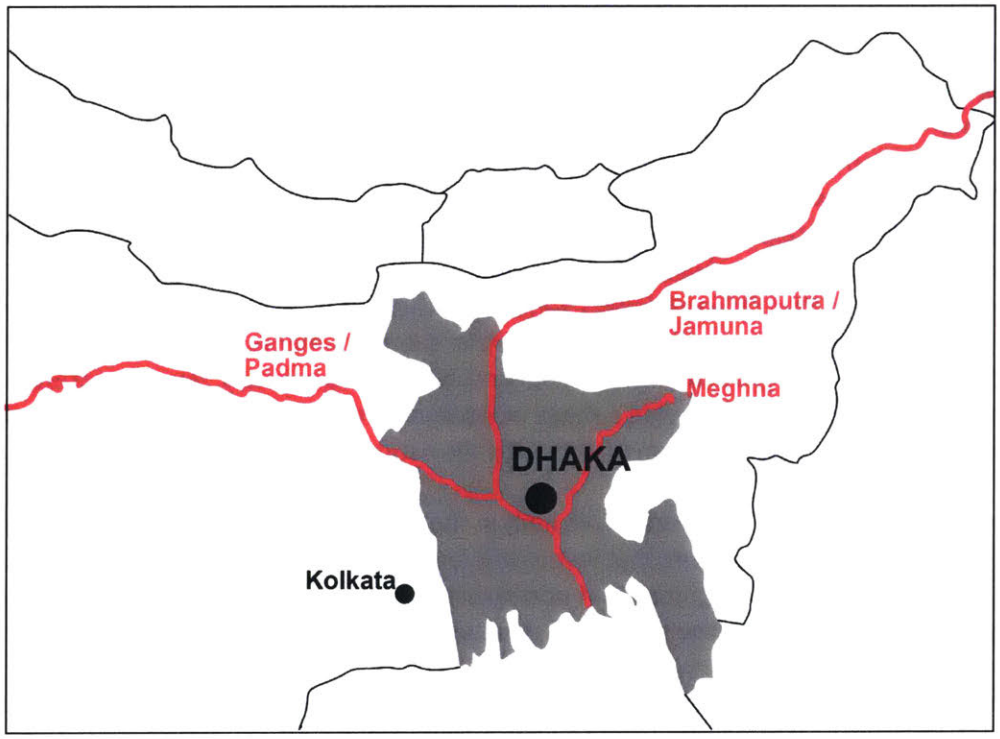


Figure 3.1. Dhaka in context.

Over the last 400 years, the population and territorial extents of the city have expanded and contracted with changes in political and economic regimes, reaching a peak population of 900,000 as a provincial capital under the Mughal regime in the late 17th century before collapsing to a low of just over 50,000 under British rule in the 1860s (Q. M. M. Zaman and Lau 2001). Since the mid-twentieth century, Dhaka has seen continuous growth punctuated by waves of in-migration following the partition of India and

Pakistan after the end of British rule in 1947 and the subsequent struggle to establish Bangladesh's independence from Pakistan. Despite longstanding political support for the decentralization of authority and growth, Dhaka remains a dominant primate city with some 5.5% of Bangladesh's overall population and 16% of the country's urban population. The population of the Dhaka metropolitan region is estimated at between 9 and 14 million while the next largest city, Chittagong has only 2.5 million. Dhaka is not only the political capital of Bangladesh, but also the center of all of the country's major institutions from finance and manufacturing to education and the arts.

As in New Orleans, for much of Dhaka's early history, permanent settlements were largely confined to the naturally occurring relative high ground. In Dhaka, this high ground is constituted by a ridge of laterite clay that runs to the north from the heart of Old Dhaka. However, with surges in the urban population, following the end of the British colonial era, settlement patterns have shifted and spread into ever more marginal and flood prone terrain. With limited readily developable land for expansion, densities in relatively flood safe areas grew dramatically, making Dhaka among the densest urban areas in the world even as public services and infrastructure lagged. This growth created deteriorating environmental conditions including serious problems with traffic, water and sanitation infrastructure, and drainage. Deteriorating and densifying conditions drove the steady spread of urban settlements into surrounding lowlands subject to inundation during the monsoon season when the region's rivers swell.

The following sections briefly introduce some of the key episodes in the historical development of Dhaka's flood and drainage infrastructure and land use planning from the city's founding more than 400 years ago to the late 20th century. In some important respects this history parallels the historic emergence and progression of New Orleans' dry city infrastructural modernization. For both cities, their tense relationships with the dynamism of the surrounding delta landscapes have been formative. In Dhaka, as in New Orleans, visions of urban growth and renewal have been linked to projects to mobilize scientific study and modern engineering to remake the relationship between water and lands. In both cities, dramatic flooding events have been catalysts for shifts in flood infrastructure and planning. By the later decades of the 20th century, city and national leaders in Dhaka had adopted a system of levee and pump-based flood protection and drainage that was, in many respects, similar to the system that was so central to urban growth in New Orleans over the course of the 20th century.

The many parallels between the rise of dry city infrastructural modernization in Dhaka and New Orleans are particularly remarkable given the radical differences between the two cities. Levees were a critical technology of urban settlement in New Orleans form the city's earliest days. Over the course of the 20th century in New Orleans, levees, pumps, pipes, and plans were crucial tools for a powerful public-private deltaic growth machine that alchemically conjured the power of land reclamation to enable periodic growth and modernization. In Dhaka, the relationship between water infrastructure and growth is more complex. For much of the city's history, it did not rely on structural and mechanical flood protection and drainage. By the time the levees came to Dhaka, the city had already undergone multiple periods of unleveed urbanization. When leaders did propose structural flood protections in the late 20th century, there was already considerable skepticism regarding this interventionist mode of infrastructural modernization based on earlier experience with flood infrastructure modernization in rural areas of the delta. Nonetheless, national leaders, emboldened by recent flooding and facilitated by international donors and consultants, pushed forward a familiar vision of infrastructural modernization. In Dhaka, as in New Orleans, proposals for flood control and drainage infrastructure were tied to particular visions of urban growth. However, whereas in New Orleans these modernizing infrastructures were seen as engines of growth and city competitiveness, in Dhaka, they were meant to control, discipline, and organize surging urban growth that had long been viewed as pathologically disordered and unsanitary.

In Dhaka, the march of dry city infrastructural modernization has not been a steady, linear, unidirectional process. Rather, proposals for 'gray' infrastructure that would enclose the city have long been countered by 'open' approaches that rely on landscape mechanisms, gravity drainage, and land use controls, approaches that align with the contemporary preference for "green and blue" infrastructures. Even Dhaka's levee boosters recognized that, to achieve the transformative change that they promised, structural protections would have to be accompanied by landscape and land use-based strategies and sweeping changes in governance and cultural practices.

A final recurring theme in the history of Dhaka's flood protection and drainage infrastructure revolves around the uneven impacts of infrastructural interventions. Though levee boosters have periodically promised that their projects will alleviate poverty and encourage greater equity, Dhaka's levees have tended to benefit powerful and wealthy interests while harming the city's poor. Levee projects have bypassed large informal settlements and altered existing waterways, blocking existing drainage routes, flooding low-lying areas, and disrupting water-based livelihoods.

Dhaka's Flood Infrastructure Planning

Over the course of the city's 400-year history, Dhaka's relationship to its dynamic delta environment has shifted radically. As described above, the city's location and configuration has been shaped by its strategic position near the junction of major distributaries of the eastern Bengal delta's principal rivers. As the city has grown over the course of the 20th and 21st century, the tensions between the demand for developable urban land and the threat of flooding from monsoon rains and surrounding rivers has been central to defining the form of Dhaka's urbanization.

'A city with many inhabitants that is neither strong nor large': pre-Mughal and Mughal Dhaka

Dhaka has historically been centered on the northern bank of the Buriganga River, a relatively placid and stable distributary of the more dynamic Jamuna. A 1927 history describes Dacca's (as the city's name was spelled until 1983) strategic position on the region's waterways, saying that the city is,

> Situated on a not too powerful river, commanding the water routes which are short cuts from the big rivers to the East and South to the big rivers to the west (Bhaltasali 1927).

Dhaka's position, on relatively high ground, *near*, but not *on* major rivers, made its site attractive for trading and settlement from at least the 13th and 14th century CE (Karim 1964; S. U. Ahmed 1986; Huq and Alam 2003) and perhaps as early as the 7th century (Dani 1962). This advantageous geography made Dhaka an appealing site for Mughal colonial expansion into the eastern Bengal delta in the early 17th century. Under emperor Jahangir, Islam Khan established the Mughal military and trade outpost at Dhaka in 1608 to support the expansion of feudal plantation agriculture in the region's rich alluvial soils. With the sanction from the Mughal powers based in the regional capital of Dhaka, zamindars (feudal landlords) throughout the eastern delta created extensive networks of canals and low embankments to drain swampland and regulate water flows to maximize agricultural production. In turn, this increased agricultural production enabled the Mughal colonial powers, based in Agra and Shahjahanabad (later Delhi), to extract more tax revenues from the colonial frontier. Dhaka's position as a colonial outpost, instrumental in the extraction of revenue through feudal agriculture would continue through nearly a century and a half of Mughal rule and nearly two centuries of British colonial rule (Van Schendel 2009).

By the height of Mughal Dhaka's "Golden Period" in the late 17th century, the city was home to an estimated 900,000 people and a bustling industrial sector centered on the production of cotton muslin textiles for export (Q. M. M. Zaman and Lau 2001; Karim 1964; S. U. Ahmed 1986). Thomas Bowrey, an English visitor to the city during the period, said of Dhaka that it was "very spacious but stood on a low

marshy swampy ground" (Karim 1964). In spite of the city's large population and low-lying position, even as the Mughal era saw extensive agricultural flood protections and reclamations, there is no evidence of substantial structural flood protections in Dhaka during this period. Aside from a short "bund" or embankment along a one-mile stretch of the Buriganga River, it appears that the residents and administrators of the city dealt with the threat of flooding largely through a network of drainage and navigation canals and by confining the more permanent elements of the city's built environment to the high ground along the Buriganga River (Dani 1962). French merchant and traveller, Jean-Baptiste Tavernier, describes Mughal Dhaka's 17th century riverfront orientation, saying that the city "extended only in length, because everyone desired to have a house by the side of the river" (Karim 1964) to access both relatively high ground and rare fresh air in the hot humid climate. Niccolao Manucci, a Venetian traveller who visited Dacca in the late 17th century observed that, "The city of Dacca, without being strong or large, has many inhabitants. Most of its houses are made of straw" (Dani 1962). This seemingly contradictory character, a city that was not "strong or large" but had "many inhabitants," largely living in structures made of light and temporary materials, suggests an important way that the city's built environment was adapted to its dynamic landscape. For much of its early history, other than symbolically important buildings such as the Governor's Palace, the factory buildings of European traders, and missionary churches, Dhaka's residents did not invest heavily in permanent and stable built environment.

British Colonial Era (1764-1947)

Along with other European trading outfits, the British East India Company established a factory and trading outpost in Mughal Dhaka in the 1660s to facilitate exports of muslin and other goods. Though the Mughal provincial capital was moved from Dhaka to Murshidabad, some 150 miles to the west in 1717, Dhaka continued to be a major administrative and industrial center (S. U. Ahmed 1986). In 1757, the British took military control of the city as part of their larger conquest of the delta region. By 1764, the Company had taken civil control of the city and the region. Though the transition from Mughal to British rule brought on substantial changes in Dhaka and the wider region, the new colonial administration followed the example of its predecessors in not building substantial flood protections for the city. By most accounts, Dhaka and the eastern Bengal Delta more generally, suffered considerable decline in the first century of British colonial rule. In 1772, a new provincial capital and port city was established downriver on the Hooghly River from Murshidabad in Calcutta, further marginalizing the former provincial capital at Dhaka. While the city's displacement as a regional administrative power center likely contributed to the Dhaka's decline, it was the destruction of both internal and export markets for muslin by the massive expansion in industrially produced textiles from English mills that disrupted the economic life of the city and lead to its dramatic shrinkage over the first century of British rule (S. U. Ahmed 1986).

Writing in the New York *Daily Tribune* in 1853 Karl Marx pointed to the decline of Dhaka and the wider region as an emblematic example of the exploitative treatment of British colonies as both sources of raw material extraction and markets for industrial goods. Marx says,

> It was the British intruder who broke up the Indian hand-loom and destroyed the spinning-wheel. England began with driving the Indian cottons from the European market; it then introduced twist into Hindostan, and in the end inundated the very mother country of cotton with cottons (Marx 1853).

In the same article Marx links the pattern of extractive colonialism to the neglect of water infrastructure necessary for navigation and flood mitigation. He says that, though the British colonial administration had put considerable state power into the apparatuses of finance and war, "they have neglected

entirely that of public works," particularly those necessary for the "economical and common use of water" (Marx 1853).

While the British colonial administration continued the Mughal practice of using land grants and revenue policy to encourage reclamation for the expansion of cultivation, there was very little centralized or coordinated investment in water infrastructure either in rural or urban areas in the Bengal delta during this time. While agricultural cultivation was expanding, the urban population and area of Dhaka declined through the late 18th and early 19th century. Where the city housed an estimated 900,000 people in 1700, by 1801 Dhaka had shrunk to 200,000 inhabitants and by 1859 it would have less than 52,000 residents (S. U. Ahmed 1986). With Dhaka's urban population in steep decline, many former urban areas were abandoned and overtaken by jungle. By the early 19th century, tigers had begun to prowl in formerly urban areas. In 1839, a British colonial official reported that "within a half a mile of the city there exists one of the most pestilential jungles in India" (S. U. Ahmed 1986). As the population of the city dropped during the early years of British rule, the predominance of temporary structures observed in the 17th century Mughal city continued. In 1800, Taylor reported that of the 43,949 houses in the city, only an estimated 1800 were "brick" solid construction, "the other all [were] thatched houses" (Taylor 1800).

Through the first decades of the 19th century, Dhaka was a provincial town in decline. Its administrative and industrial importance had receded. As the jungle closed in on the city, Dhaka consisted of a small permanent settlement clustered on the high ground along the Buriganga riverfront. The vast majority of the built environment of the city was comprised of the type of lightweight, provisional, and moveable structures that were (and are) common throughout rural settlements in the delta.

Improvement and Sanitation: The second century of British colonial rule

Though the scope and scale of colonial water infrastructure interventions in the Bengal delta grew during the second century of British colonial rule, public investments in flood infrastructure for Dhaka remained limited through the end of the colonial era. Where colonial authorities did intervene in Dhaka's waterscapes, their plans and projects were driven by the same preoccupation with sanitation that characterized colonial urbanism throughout British India and beyond (McFarlane 2008). The projects of "civic improvement" undertaken in this era tended to conflate aesthetic concerns over unsightly vistas or unpleasant odors with public health worries centered on preventing the spread of epidemic disease. Beginning in the 1820s, colonial officials began to identify the physical conditions of Dhaka as problematic and in need of "improvement." Early efforts included largely unsuccessful attempts to levy taxes for sanitation improvements and expansion schemes to develop urban environments for colonial officials that met their standards for spatial order and infrastructure. These urban expansions tended to extend to the north, reoccupying areas previously occupied by Mughal settlements and naturally elevated above seasonal floodwaters (S. U. Ahmed 1986).

The ambition and scale of plans for urban improvement in Dhaka expanded in the late 19th century following the transition of administrative authority from the British East India Company to British Crown rule in 1858. Though many proposals for improvement had been put forward over the previous decades, conditions in Dhaka were still quite objectionable in the eyes of colonial officials. The Civil Surgeon of Dhaka, Dr. James Wise wrote in his 1866 report on the city that, "Dacca has long been famed for its uncleanliness" and for being "the most filthy of towns" (Simpson 1868). To address these deficiencies, Wise argued that, "What is required in a large city is a health officer with almost despotic power" (Simpson 1868). In a report outlining the most ambitious colonial sanitation improvement proposals, civil surgeon Dr. Henry Cutcliffe described Dhaka's aesthetic and health concerns vividly, saying,

> the air which the people breathe is dangerously impure; ... the water which they drink is horribly polluted; and ... the soil on which they reside, besides being porous, damp, and undrained is made up very greatly of the decomposing excreta of the present, and the more or less decomposed remains of the past generation (G. Graham 1869).

To remedy these problems, Cutcliffe and his allies proposed a program of new sanitary infrastructure, restructuring the existing urban fabric, straightening and widening roads and building a new sanitary city expansion. This new territory would be produced through the reclamation of "land which is now covered with heels, swamps, and jungles."

To fund this ambitious effort, Cutcliffe proposed that the municipality use a combination of new taxes and an entrepreneurial approach to real estate development. In his report, Cutcliffe proposed that civic improvements in Dhaka could be partially funded through revenue generated through reclamation of new lands, saying "after having drained and leveled" new land, city leaders could "build over it houses which would command remunerative rents." He assures colonial administrators in Calcutta that "money, judiciously invested in the improvement of the city, would return a very high rate of interest" (G. Graham 1869). Cutcliffe's proposal for civic improvement and expansion through entrepreneurial public-led land reclamation and drainage is reminiscent of New Orleans' Progressive-era drainage and reclamation projects of the late 19th and early 20th century. Though one prominent municipal commissioner raved that the proposal would transform Dhaka and "make a heaven of hell," the proposal, like those that came before, largely languished because the necessary funds could not be raised either by taxation of a resistant local population or from reluctant colonial administrators (S. U. Ahmed 1986).

While Cutcliffe's proposal included reclamation of swampland and drainage improvements, it did not discuss the threat of urban flooding from the surrounding rivers. The project that is frequently cited as the first public effort to combat river flooding in Dhaka, the Buckland Bund, was initiated just a few years before the Cutcliffe plan. The Buckland Bund was a masonry hardened riverfront embankment that ran for less than one mile along the Buriganga riverfront in an area that is now Old Dhaka. While the Buckland Bund occupies an important place in the history of Dhaka's waterfront, the common characterization of the project as the city's first public flood protection structure should be questioned for a number of reasons. First, as previously discussed, during the 17th century, Mughal authorities had built a bund along part of the same stretch of riverfront that was later occupied by the Buckland Bund. Second, though the Buckland Bund was initiated in 1864 (the same year that a municipal government was established for the city) by the colonial commissar of the city, Lieutenant Colonel Charles Buckland, the bund was not primarily a public effort. Rather it was paid for by subscription from the wealthy families who owned property along the adjacent riverfront (S. U. Ahmed 1986; Mandel 2011).

Similarly, though scholars frequently point to the Buckland Bund as the first major effort at addressing river flooding in Dhaka (Huq and Alam 2003; Mandel 2011; S. U. Ahmed 1986; M. Alam and Rabbani 2007), there is little evidence that flood prevention was a primary concern. Rather, the rationale for the Bund seems to have been a combination of encouraging riverfront commerce, imposing aesthetic order on an otherwise unruly edge between land and water, and providing an amenity for urban elites. The area on which the Bund was constructed was previously occupied by mud flats, which, during the dry months stretched for some distance and made loading and unloading of cargo from river vessels difficult. By establishing a hard and consistent edge, closer to the navigable channel of the river, the Bund enabled the city's riverfront commerce. Though the Bund was a bustling hub of commerce, it was also jealously guarded as an aesthetic amenity for wealthy Dhaka residents. The Bund offered a space of

relative tranquility, a place for the city's elite to promenade and escape the climatic and aesthetic discomfort of the city (S. U. Ahmed 1986).

Colonial records include many references to conflicts over the space on and adjacent to the Bund. In one example of the conflict between commerce and aesthetic appreciation of the Bund, the chairman of the municipality sent a letter to one riverfront property owner in 1922 stating,

> I have the honor to request you to kindly keep your cow-shed facing the Buckland Bund neat and clean so that it may not emit as it does now, obnoxious smell causing a great nuisance to the public resorting to the bund for recreation (Dacca Municipal Commission 1922).

Colonial records also include references to a wide range of activities and entities that were prohibited from the Bund, including: bicycles, boats under repair, bricks, bullocks, cars, carts, clothes washing, dogs, drains, elephants, filth, firewood garbage, goats, hawkers, horses, lambs, planks, obnoxious smells, ropes, sand, stone chips, and trucks (Dacca Municipal Commission 1922). This intense spatial contestation over the riverfront embankment during the colonial era continued through the East Pakistan period and into the contemporary era. The Buckland Bund represents one prominent example of a broader pattern of government officials and local elites seeking to use water infrastructure as a means of imposing order on an environment that they regarded as unacceptably chaotic and unsanitary.

Though the Bund did prove to be a success from the standpoint of commerce and recreation, it does not appear that it was ever intended for the flood control purposes that many later observers have ascribed to it. Even after multiple extensions over the twenty years following the initiation of the project, the Bund only reached three-quarters of a mile in length (Mandel 2011). As a single linear structure stretching over only a small portion of the city's waterfront, the Bund would have done little to stop river flooding from entering the city. A 1924 letter from the Municipal Office to the office of the Nawab's Estate (one of the primary landowners along the Bund) makes a rare connection between flood alleviation and the embankment, requesting permission to raise the elevation of one section of the walkway "over the flood level." However, even here, the writer's concern is not with protecting the land behind the Bund from river flooding. Rather, the elevation of the walkway is said to be "for the convenience of foot traffic" in an area "where a large number of people like their morning and evening constitutionals" (Dacca Municipal Commission 1925).

Even as Dhaka's population level continued to recover in the early decades of the twentieth century, municipal officials and civic improvement advocates did not call for major structural flood protections for the city. When Patrick Geddes conducted his survey of Dhaka in 1917 he continued in the tradition of earlier colonial proposals. Like Cutcliffe and other predecessors, Geddes was primarily concerned with improving sanitation, including through draining low-lying areas. Geddes' proposal centered on a linked system of barge-based dry sewage collection, canal improvements, canal-side parklands, and urban market gardens. Geddes linked functional problem solving with a scenographic emphasis on the visual experience of the urban landscape. He remarked that the "picturesqueness" of the city's canal network could be improved through a "constructive collaboration in which the painter's eye goes with the planter's hand" (Geddes 1917). In his discussions of the riverfront, Geddes again focused on the visual and aesthetic experience of the place and has nothing to say regarding any need for flood control structures. He says, "The very best of all the open places of Dacca is of course its River front." As such, Geddes calls for extending the Bund, which he refers to as "the Esplanade Embankment," in order to create more riverfront land through reclamation (Geddes 1917). Thus, while Geddes identifies the canals and riverfront as the primary spaces for intervention to improve the urban experience of Dhaka,

there is no evidence in his report or in his correspondences that flood protection played a significant role in his analysis or proposals.[1]

Embankments as Tools of Rural Extraction

While Dhaka's colonial administrators and planners did not make use of embankments for urban flood prevention and growth, embankments were commonly deployed throughout the eastern Bengal delta for a number of purposes including protecting agricultural estates and later elevating railroad lines. In the early years of British rule, the zamindars were responsible for constructing and maintaining embankments to protect their agricultural estates. This fragmented approach came with the clear problem that the fate of each landowner rested not only in the strength of their own embankments, but also in that of his upstream and downstream neighbors. Thus, the colonial administration gradually increased their involvement in embankments. As early as 1785, colonial agents were tasked with making repairs to embankments. In 1803 an Embankment Commission was established to coordinate public and private embankment construction and maintenance (Wescoat 1990). In spite of these efforts at coordination, an 1846 report decried the disconnected and fragmented system of embankments, saying,

> The disjointed nature of the bunds... induce to this belief, that they have originated in the caprice or cupidity of the zemindars (Sage, McClelland, and Simms 1846).

In efforts to better coordinate embankment construction and repairs, a series of legislative acts were passed by colonial authorities over the late 19th century, creating a classification system of public and private embankments and setting out the relative responsibility of the government and private landowners for undertaking and funding construction and maintenance work in each category.

Though the colonial administration gradually expanded the network of flood control and irrigation embankments across the delta, there were early voices both within and outside the colonial administration calling for caution and observing the dangers of these infrastructural mega-projects. An 1846 report by a commission headed by William Sage, the superintending engineer of the Southeastern Provinces, observed a wide range of problems associated with embankments in the delta (Sage, McClelland, and Simms 1846). The Sage Commission reported that the problems caused by embankments included: siltation of riverbeds; the threat of catastrophic flooding in the event of breaches; and waterlogging behind embankments. The commission held that, though embankments had proven useful in Europe, the Bengal delta presented a wholly different set of conditions, saying "no embankment can resist, the natural tendencies of these rivers, to find the easiest channels." The commission recommended that the delta's embankments be removed and the delta "return[ed] to the state of nature, which... ought never to have been departed from" (Sage, McClelland, and Simms 1846). The Sage report brought to light many of the criticism of embankments that would be repeated in subsequent debates in the Bengal and Mississippi deltas. Nonetheless, colonial authorities swiftly and furiously rejected the report's critiques.

In addition to the colonial embankments for flood control and irrigation, state-sanctioned private railroads began to build a network of railroad embankments throughout the Bengal delta in the late 19th century. In his environmental history of the Bengal delta, Iftekhar Iqbal identifies the railway embankments of the late 19th and early 20th century as critically altering the hydrology of the delta, bringing on a range of negative social and public health impacts (Iqbal 2010). In spite of rising concern in

[1] Some correspondences between Geddes and Dhaka-based colonial officials suggest that his visit to the city was brief and that it corresponded with a time of particularly low water in the canals. In fact, in one letter from before his visit in 1917 one S.G. Hart recommends that he postpone his visit until the rainy season when water level in the canals will be higher.

the late 19th century, colonial officials downplayed the negative impacts of railroads and prohibited local officials from allowing the cutting of railroad embankments to "let off" water (Iqbal 2010).

By the early 20th century, the expanding network of river and railroad embankments were increasingly blamed for impeding the hydrology of the delta. In 1927, Dr. P.C. Mahalanobis, a prominent professor at Presidency College in Calcutta, issued a report that blamed the delta's railroad and flood embankments for worsening the floods of 1922. Mahalanobis echoed the Sage Commission's concerns about the long term impacts of river embankments on siltation (Mahalanobis 1927). To cope with the danger of flooding in the region, Mahalanobis recommended a combination of less interventionist strategies including: removing drainage obstructions; improved data gathering and warning systems (modeled on the systems created in the Mississippi River region of the USA); and encouragement of small scale adaptive building and living practices. Mahalanobis places special emphasis on strategies to adapt living patterns to the periodic flooding of the delta, saying

> It would be necessary therefor to advise and educate the inhabitants to adapt their life to the changing conditions: to build their houses, as far as possible on high ground; to make provisions in their houses for raised platforms where human beings may take shelter during high floods; and also to construct raised mounds in the villages where grain and valuable properties may be removed in times of danger (Mahalanobis 1927).

Prominent Bengali geographer Radkamal Mukerjee voiced his own criticisms of embankments in his 1938 book, *The Changing Face of Bengal*. Mukerjee blamed flood control and transportation embankments for degrading the delta, saying,

> The climate has become unhealthy, where the natural drainage has become disorganised, an indirect consequence of the degradation of former tributaries of the Ganges into stagnant lagoons, and the construction of numerous embankments and high roads along the natural drainage channels (Mukerjee 1938).

He identified a "train of evils" brought on by embankments, including siltation of channels, raising flood stages, and causing waterlogging and attendant health impacts such as malaria. Mukerjee regarded the issue of the delta's embankment in broad moral terms, depicting these infrastructures as "Man's Invasion in the River's Domain" and warning that "Famine and flood equally publish man's crime against nature and nature's stern rebuke." Finally, Mukerjee recognized that construction of embankments brought on a cycle of path-dependent lock-in wherein, as embankments caused siltation and higher flooding, they would "have to be continuously raised and strengthened" to keep the water at bay (Mukerjee 1938). Mukerjee's critiques reflected his almost mystical vision of human and natural holism. Like Patrick Geddes, with whom he had a periodic correspondence, Mukerjee called for a synthesis of modern scientific inquiry across realms typically regarded as distinct, saying

> Man's future advance lies, indeed, in a bio-economic co-operation, based on scientific study and comprehension of the complex web of life that comprises both the animate and the inanimate realms; and this is deeper and more far-reaching than co-operation merely within the human community (Mukerjee 1938).

Thus, in Mukerjee's reading, the embankments were part of a mode of inhabiting the delta that was fundamentally at odds with the forces of the landscape and with the goal of building a holistic and harmonious relationship between people and their place. These levee critiques preview criticisms that would become more common in both the Bengal and Mississippi deltas in the late 20th century. They also resonate with the McHargian concepts of 'ecological planning' and landscape suitability that have become central to contemporary projects' promises of 'living with water' and 'design with nature.'

East Pakistan Period (1947-1971)

Less than five years after the publication of Mukerjee's seminal work and its indictment of the embankments of Bengal, the region suffered from the disastrous famine of 1943. Some observers place the disruption of the region's hydrology among the socio-ecological causes of the disaster, which killed an estimated two to three million Bengalis. In the wake of the famine, widespread popular uprisings, and the devastation of the British economy following World War II, British colonial rule ended in 1947. With the end of British rule, Bengal was divided into the Indian state of West Bengal and East Pakistan, a province of the new Muslim-majority nation of Pakistan.

The East Pakistan period, which persisted until Bangladeshi nationalists won independence in 1971, was marked by major shifts in the state's approach to water management. For the bifurcated state of Pakistan, whose two constituent parts were separated by more than 1000 miles of Indian territory, modern water infrastructure development featured prominently into the project of state making. As was the case in several early and mid-20th century dam mega-projects, from the Aswan Dam in Egypt (Mitchell 2002), to the Marathon Dam in Greece (Kaika 2006, 2004), to the Boulder Dam in the western USA (Nye 1996), the water planning undertaken during the East Pakistan period in the Bengal delta sought to mobilize the power of modern engineering to build infrastructures that would tame unruly landscapes in support of the construction of national identities and national economic development. Though these plans for infrastructural modernization largely ignored Dhaka, the largest urban settlement in the region, they were crucial for setting the path of water planning in the delta for generations to come, in building a preference for structural flood protections, creating new hydraulic bureaucracies to develop those protections, and establishing a prominent role for international networks of financial aid and expertise.

Two linked projects undertaken in the 1950s and 60s were critical to setting the course of water management in the Bengal delta during the East Pakistan period. The first was the 1957 report from a UN "Water Control Mission" entitled "Water and Power Development in East Pakistan," which is commonly referred to as the Krug Commission Report after the mission's chairman and former US Secretary of Interior J.A. Krug. The second was the Master Plan produced for the newly formed East Pakistan Water and Power Development Authority (EPWAPDA) conducted by the US-based engineering consultancy International Engineering Corporation (IECO) and released in 1964. These two documents and the projects and institutions that they birthed marked a shift towards interventionist water management as a part of broader projects of modernization and nation building.

In 1954, 1955, and 1956 the eastern Bengal delta suffered three successive years of severe flooding. In the response, the new territory of East Pakistan became the venue for the demonstration of power on a number of fronts. For the United Nations, only entering its second decade of operation in 1955, the Water Control Mission was part of forging a new model of international development aid and knowledge transfer. The choice of the Mission's chairman, J.A. Krug, an executive at the Tennessee Valley Authority, signaled not only the growing role of the USA in the post-war development landscape, but also the mission's adoption of an infrastructural modernization approach that tied flood mitigation to other "water resource management" concerns including power and agricultural production. Krug's team on the mission was composed entirely of engineers and economists including: two British hydraulic engineers, another TVA flood control expert, an economist from Cal Tech, and a Dutch water and development expert (United Nations Water Control Mission 1959).

For the government of Pakistan, the flood response was an opportunity to demonstrate the national government's commitment to East Pakistan's development. The years leading up to the flooding of the

mid-1950s had seen the development of a powerful political movement for provincial autonomy. In 1954, a coalition of pro-autonomy political parties called the United Front issued a twenty-one point manifesto, which explicitly identified flood infrastructure among their core concerns and linked flood mitigation with agricultural development. The Manifesto called on the government "To protect the country from flood and famine by means of digging canals and improving irrigation system" (Van Schendel 2009). The Pakistani government's flood response, the Krug Commission, and the infrastructure projects that followed were an opportunity to demonstrate to a restive province the legitimacy of the distant central government by delivering on an agenda of modernization and development.

In their final report, the Krug Commission recognized the importance of their project to the goal of nation building, saying that in the development of flood protection infrastructure, "the very existence of East Pakistan is at stake" (United Nations Water Control Mission 1959). The report goes on to frame their charge in heroic terms where the challenges are herculean, but the potential outcomes of success are transformative,

> The human implications of the undertaking stagger the imagination. Forty-five million people who live today under the imminent threat of disease and starvation, would advance to a new and vastly better way of life. Misery and starvation would be replaced by confidence and health. Gone would be the ever-present fears of flood on the one hand, and famine on the other. Secure in their lives and property, the people would be able to plan, to build, and to make progress. For the first time, all their energies could be devoted to the improvement of their economic and social conditions. With more food, and new power sources, living standards should rise to the highest levels they have ever known. East Pakistan would go forward toward a bright new promise of abundance and prosperity (United Nations Water Control Mission 1959).

The commission outlined a series of recommendations for developing an integrated nation-wide plan for flood control, electrical power development, irrigation, and navigation. The commission regarded major structural flood protection as integral, stating,

> Our proposal is to concentrate on the possibility of protective embankments to safeguard the most vital production areas and to expedite clearing and straightening of the smaller rivers. This will give maximum encouragement to the rivers to stay in their channels and to move surplus water, silt, and sand most efficiently to the sea (United Nations Water Control Mission 1959).

The Krug Commission report lays out a program in keeping with the efficiency maximizing approach to structural flood infrastructure that dominated water planning across much of the world in this era. The report's recommendations were nearly entirely focused on rural development.

Though the Commission's report displays a deep faith in a modern techno-managerial approach to water development linking knowledge, bureaucracy, and engineering, the caricature of the report as a single-minded levee promotion exercise misses some key countervailing themes that will reappear in later water resource planning efforts. Far from blindly advocating new structural interventions, the report repeatedly emphasizes that the complexity of the "flood problem" in the delta required careful study and caution. Like Mukerjee and Mahalanobis, the authors recognize that embanking rivers can increase flood levels, saying,

> Before any action is taken which might raise flood levels, the consequences to towns, villages and especially valuable agricultural land should be carefully considered. Measures should be taken to raise or protect such areas, so that they will be safe against the expected higher flood levels.

They also recognize the familiar threat of the so-called "levee effect" wherein embankments actually lead to more severe damage, saying,

> If an embankment is breached, the damage and loss of life caused in the area near the breach may well be far worse than would have occurred if no embankment has been erected, especially if a false sense of security had been created.

Recognizing these limits to structural flood protections, the Krug Commission embraces the need for regulating land use through "flood zone planning." Thus, while the Commission's report puts a great deal of faith in the combined powers of data, bureaucracy, and infrastructure, it also urges caution and recognizes the importance of alternative approaches to structural intervention.

Even while urging caution, the Krug Commission report assumes that major structural interventions are the inevitable and only solution, invoking a great sense of urgency to motivate action. Echoing the report's frequent invocations of exigency, the letter from a Pakistani official that accompanies the report states that, "there is no time to lose" in starting East Pakistan's infrastructural modernization. The authors repeatedly betray a tone that "there is no alternative" to structural embankments, at one point stating that "the confining of floods to the river channels is the only available way to reduce materially the total area flooded." This combination of caution and openness to alternative approaches paired with stark warnings, invocations of urgency, and barely veiled biases towards structural interventions, run through the Krug Commission report and is evident in similar projects into the present day.

The Krug Commission paid remarkably little attention to Dhaka and the other urban areas of the province. Throughout the report, Dhaka is mentioned only briefly. When it is invoked, the city is treated not as a potential site for intervention, but as a market for electrical power and agricultural production or as the home of key administrative and educational institutions. The only instance in which the Dhaka area is mentioned as a site for intervention comes in the discussion of potential pilot projects for linked poldering and pumped irrigation. In the years after the Krug Commission report, this suggested pilot project would eventually lead to "Dacca – Narayanganj – Demra Irrigation Project." This peri-urban agricultural poldering project, which became known as the "DND" project, would be carried out with the assistance of the International Development Association (IDA), a component of the World Bank, and become a frequently invoked example of a poorly planned flood control, drainage, and irrigation (FCDI) project. The next chapter will take up the story of the DND project as an example of the frequent mismatches between the tidy infrastructural modernization visions and the complex and unexpected ways in which these projects have shaped urbanization.

The illustrations included in the Krug report support the vision put forward in text wherein water development and national development are linked through the nexus of scientific knowledge, efficient bureaucracy, well-engineered infrastructure. The report includes a series of oblique and orthogonal aerial photographs of the major rivers. These aerial images along with a series of hydrological diagrams showing river profiles, discharge rates, and other key data, suggest a new way of seeing and analyzing the region's waters that is abstract, quantitative, and detached from human use and impacts (Figure 3.2). The vast majority of the maps included in the report encompass the entire territory of East Pakistan, reflecting the Commission's vision for provincial development through large-scale infrastructural investment.

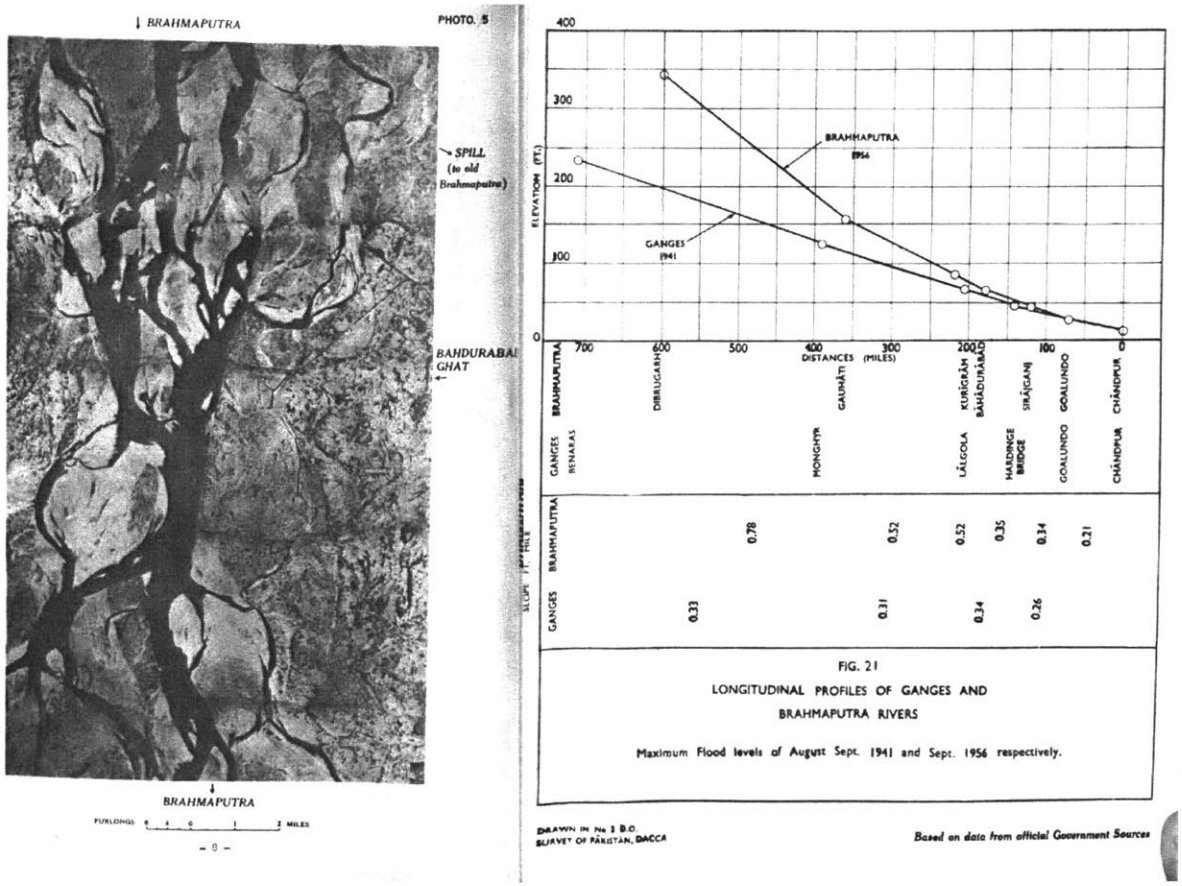


Figure 2. A distant, quantitative, and abstract perspective on the delta. Krug Commission Report (1959)

IECO Master Plan

The analyses and recommendations of the Krug Commission were very much in line with the dominant mid-20th century resource planning ethos in the USA as embodied in such institutions as the USACE, TVA, and the Department of Interior, where some of the Commission members made their careers. These institutions stood for comprehensive, multi-purpose planning informed by scientific knowledge and implemented by efficient bureaucracy. The International Engineering Corporation (IECO), the major contractor for the DND project as well as the larger 1964 EPWAPDA Master Plan, represented another important pole in the post-war American planning and development regime: private engineering and construction contractor. IECO was a San Francisco-based subsidiary of Morrison Knudsen (MK), the massive global engineering and construction firm that built the Hoover Dam. The firm was an integral player in the USA's military expansion during the second World War. After the war, MK leveraged their global wartime experience into a range of development and military projects all over the world. In 1954, Harold Morrison, co-founder of the company was featured on the cover of *Time* magazine celebrating "Builders Abroad – Ambassadors with Bulldozers" (Figure 3.3). MK established IECO in the 1950s to furtherer their engineering and infrastructure business in less developed regions, in the words of that *Time* cover, "to tame rivers and move mountains."

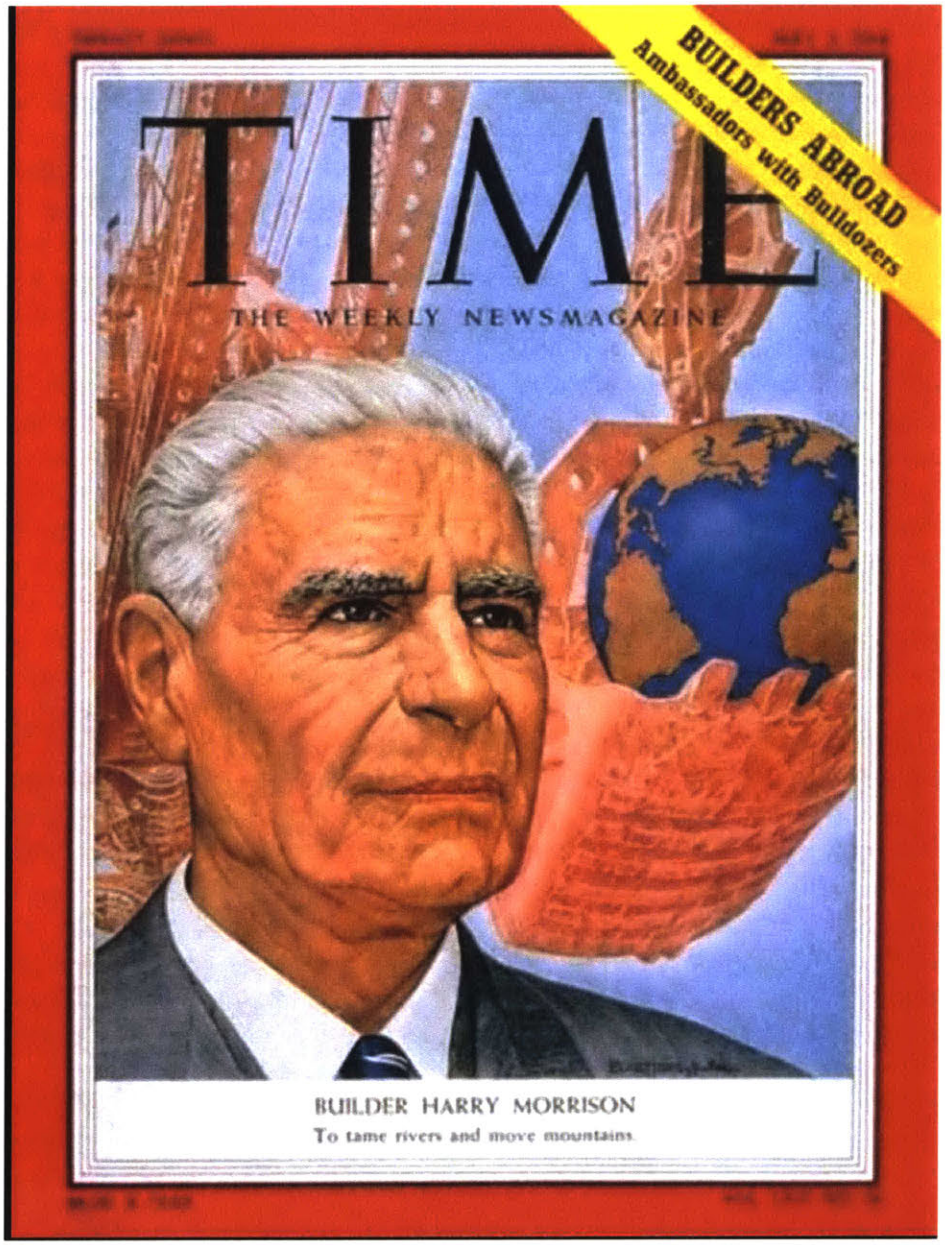


Figure 3.3. *Time* magazine cover from May 1954, celebrating "Ambassadors with Bulldozers," featuring Harry Morrison, the founder of Morrison Knudsen, the parent company of IECO, an important player in the mid-20th century infrastructural modernization of the Bengal delta.

Like the Krug Commission report, the 1964 IECO Master Plan was rooted in US federal government resource planning practices. Included with the final report document is a support letter from General John R. Hardin, a former Chairman of the Mississippi River Commission and General Raymond A. Wheeler a former Chief Engineer of the US Army Corps of Engineers (EPWAPDA and IECO 1964).

The EPWAPDA Master Plan followed the pattern set out in the Krug Commission report, focusing squarely on increasing agricultural and electric power production in the name of province-wide economic development and modernization. The IECO documents layout out a 20-year plan calling for construction of thousands of miles of embankments and hundreds of individual polders in 58 distinct

flood control, drainage, and irrigation (FCDI) projects estimated to cost $2.1 billion (nearly $16.5 billion in 2017 dollars). The plan, like the Krug report before it, emphasizes the nexus of scientific knowledge, rational and efficient bureaucracy, and engineered infrastructure as a means of harnessing water resources as part of "the total plan for strengthening the economy of East Pakistan." (EPWAPDA and IECO 1964) The plan argued that a massive program of infrastructural modernization was necessary to achieving the Government of Pakistan's goals of furthering economic growth and equity,

> to develop the resources of the country as rapidly as possible so as to promote the welfare of the people, provide adequate living standards, social services, equality of opportunity and aim at the widest and most equitable distribution of income and property.

Like the Krug report, the IECO plan focuses almost exclusively on rural development, all but ignoring Dhaka and the other urban areas.

The IECO report largely glosses over any ambiguities or misgivings that the Krug report expressed regarding structural flood control, arguing that "the only available method of reducing the flooded area is confinement of floods to the river channels" (EPWAPDA and IECO 1964). Building off of this assumption, the report calls for more structural protection, saying,

> The flood protection features of Master Plan projects for development of water resources in East Pakistan are based on exclusion of river flood water by embankments and removal of excess rainwater accumulations within the respective project areas by sluicing or pumping.

In the logic of the IECO report, the goal of advancing a "more efficient use of the arable land," required "extensive engineering works in strong opposition to the processes of nature" in order to overcome the "fundamental inadequacies of surface drainage in East Pakistan." The report regarded the delta landscape as flawed and in need of intervention to advance regional development goals.

Like the Krug report, the IECO plan calls for "comprehensive" and "integrated" resource planning, tying together agricultural development, flood control, power supplies, and navigation. Seeking to overcome what they saw as the shortcomings of previous sectoral plans and "project-by-project" approaches. The plan argues for multi-purpose projects that could bring benefits in more than one aspect of the region's development, saying, "where feasible, designs are for multipurpose development to maximize benefits."

As models for the proposed work in East Pakistan, the IECO plan repeatedly refers to the model of the Mississippi River flood control system and the system of dike and pump-based agricultural polders in the Netherlands. Though they recognize that the dynamism and power of the rivers in the Bengal delta are without parallel, the authors argue that the Mississippi River represents "probably the most instructive example of flood protection on a waterway" that is "fairly comparable." In making the case for major embankment structures in East Pakistan, the IECO plan argues that, "in the lower Mississippi, embankments have been required and are now the tested and principal means of flood protection." The plan advocates for "the simple and direct procedure of enclosing an area with embankments to exclude flood water, as developed along the delta of the Rhine River in the Netherlands" (EPWAPDA and IECO 1964).

Infrastructural Modernization as Dependent on Non-Structural Reforms

While the IECO Master Plan is even more committed to the Promethean model of dry city infrastructural modernization than the Krug report, the Master Plan, like its predecessor, includes many statements of caution, concern, and appreciation of the need for complementary and alternative approaches. The IECO authors repeatedly acknowledge that, in East Pakistan "basic data are still scanty," and therefor "it is inevitable that errors of judgment will be made." To overcome these knowledge deficits and minimize errors, the plan calls for incrementalism, periodic review, and continuous learning through action. To

that end, the authors argue that the plan "is properly flexible and adjustable to future experience," "rather than being final or ultimate." This need for sustained knowledge accumulation and learning through experience is at the heart of the plan's advocacy for strengthening the bureaucratic structure of the EPWAPDA, which was first created after the Krug report.

The IECO authors recognize many of the familiar critiques of river embankments, saying such interventions "increase the hazard to those living on the lowlands" outside of protected zones. To overcome these dangers, the Master Plan argues that "some controls will be necessary to prevent development taking place without regard to the degree of protection being provided." They call for retaining traditional raised settlement types as well as, "increased watchfulness along the embankment" and developing "effective communication system whereby timely warning can be given" of impending floods. In their supportive letter attached to the plan, Generals Hardin and Wheeler also explicitly recognize the "levee effect." To counter the often-cited "false sense of security" that can come with embankments, the Generals argue that people living behind these protections must be "made aware, and be continuously reminded of, their dependence upon works of man for their safety and the need for being alert to the possible occurrence of extremes in natural phenomena" (EPWAPDA and IECO 1964).

Just as the IECO plan recognizes that embankments must be accompanied by regulatory and communication actions, the report acknowledges that achieving agricultural productivity goals will also requires major complementary efforts. In the plan's terms, "The present day agricultural economy rests upon a populace of illiterate, subsistence farmers who live and work under primitive conditions on very small fragmented holdings" (EPWAPDA and IECO 1964). They argue that, "if the man behind the plow is to fulfill expectations," the government must address a whole suite of issues including farm education, research, tenure systems, pricing, and land holding patterns. Furthermore, the plan holds that these changes must go beyond state activities to the very hearts and minds of the farming populace to radically reshape their generations-deep understanding of how their landscape functions,

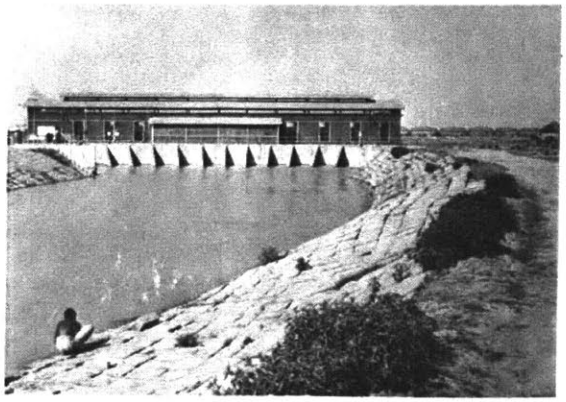
> It will be necessary to adjust many long established practices, especially in agriculture, and to adopt new concepts and methods. The belief that present flooding is essential for fertilization and watering of farm lands must be replaced by acceptance of the analyses discounting the fertilizing value of silt itself. Also it must be accepted that access to the land at all times in the year and control of supplies will assure greatly increased returns. (EPWAPDA and IECO 1964)

Even as the IECO Master Plan recognizes major gaps in basic scientific knowledge, the inherent dangers of structural flood protections, and the need for extensive programs of bureaucratic and social transformation in order to manifest the benefits of the plan, the authors insist that there is no alternative to urgently beginning the program of structural intervention. They argue that, "Even though much more data are required, it is obvious East Pakistan cannot wait for the accumulation of additional data but must plan now from what is available" (EPWAPDA and IECO 1964). The authors frequently cite population growth as a motivation, saying, "population has grown so rapidly that the need for action has become urgent." The plan's dramatic interventions are justified by dire Malthusian predictions, which have fundamentally altered the understanding of the region's hydrology.

> The flood cycle in East Pakistan assumes greater importance as a growing population presses for living space and food. Consequently, flooding is now being viewed as a problem to be solved rather than something which must be tolerated as in past decades.

Just as the Krug report made the case for urgent action on the basis that the flooding threat represented an existential threat to the existence of East Pakistan, the IECO plan similarly invokes the promise of "economic and political stability" in justifying the "massive effort" it recommended.

To emphasize the themes of modernization, the IECO report includes a series of photographs juxtaposing pre-modern peasants and modern infrastructural interventions (Figure 3.4), and celebrating the new modern bureaucratic state (Figure 3.5).



Auxiliary Pumping Plant, Bheramara

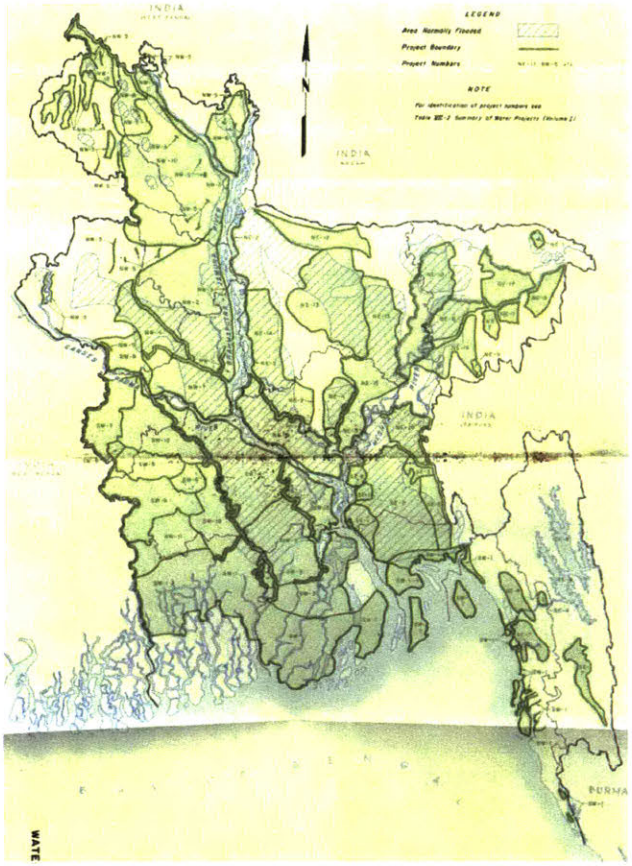
Plowing With Wooden Plow

Figure 3.4. Illustrative photos from the IECO report juxtaposing modernizing infrastructure with pre-modernization agricultural practices.

EPWAPDA Headquarters, Dacca

Figure 3.5. Left: EPWAPDA's Dhaka headquarters building from the EICO master plan.

The IECO plan includes several maps showing the extensive system of river embankments and polders proposed (Figure 3.6). The plan includes a series of stylized river system diagrams showing the "Flood Flows" and "Minimum River Flows with Irrigation Fully Developed" (Figure 3.7). In these diagrams, the river system of the delta is depicted schematically as a network of connected arrows whose relative widths illustrates the flow volumes of the individual channels. These diagrams vividly reflect the hydrological science and systems engineering perspective that dominated this planning effort, showing rivers as discrete, quantitatively knowable, and thus, alterable entities.



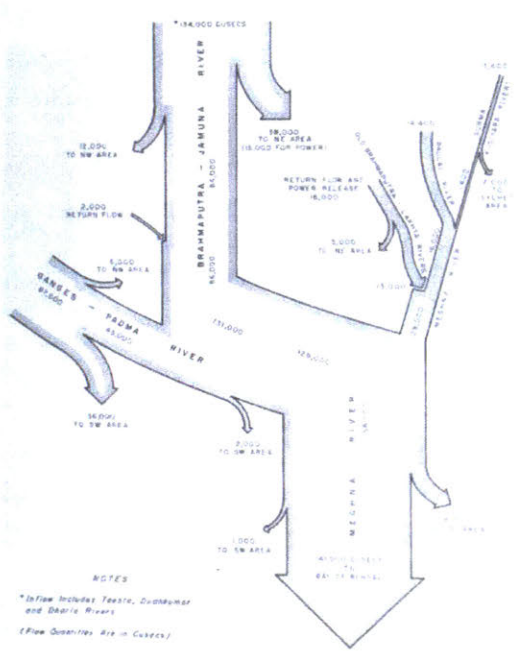


Figure 3.6. Left: "Water Projects" proposed in the IECO Master Plan.
Figure 3.7. Right: River system flow diagram from the IECO Master Plan.

Dhaka as a Market and an Administrative Headquarters

As with the Krug Commission, the IECO report's primary metric for success was agricultural production. This emphasis on agricultural production led to evaluation criteria that favored those projects that would maximize the "project benefit by area", encoding a rural bias in the plan. As such, Dhaka and other urban areas were again treated primarily as markets for agricultural commodities and electric power. Though the plan does not discuss flood vulnerability in Dhaka or make any substantive proposals related to the relationship between urban settlement patterns and flooding. Aside from the previously discussed DND Irrigation Project and two other peri-urban agricultural poldering and irrigation projects, the IECO plan does not make any proposals for work in the Dhaka region.

The disregard of urban water management in the IECO plan is especially striking given that the plan explicitly embraced a model of development premised on urbanization and industrialization, saying, "Economic development should follow the present world trends toward continued urbanization and industrialization to accompany intensified land use in agriculture" (EPWAPDA and IECO 1964). The plan embraced urbanization, but did not consider, even briefly, the flood vulnerability of these urban areas or how massive infrastructural interventions might change settlement patterns in urban areas.

Subsequent water planning efforts and critiques have sometimes caricatured these East Pakistan water plans as single-minded levee building mega-projects. In this narrative, planners and engineers look back on these early efforts with scorn, scoff at their naïve assumptions, and reassure themselves that they, the new generation, are finally instituting a truly comprehensive and integrated approach to water

management, where their predecessors were blinded by short-termism, disciplinary boundaries, or insufficient attention to the holistic impacts of their proposals. Indeed, these early plans were radically simplistic and unrealistic in their assumptions about the transformative potential of water infrastructure. Both the Krug report and the IECO plan are imbued with an unmistakable mid-century optimism regarding the combined powers of scientific knowledge, bureaucratic efficiency, and modern engineering. However, these reports repeatedly invoke the need for integrated and comprehensive scientific knowledge and acknowledge deep uncertainty and the need for more complete data in the case of East Pakistan's water resource planning. They also both acknowledge the negative impacts of structural flood protections and insist on the necessity of various complementary activities to overcome these deficits and realize the transformative potential of their recommended interventions. In spite of these cautions, both efforts invoke a sense of urgency and existential threat to justify moving boldly forward. In later sections of this chapter and subsequent chapters, similar patterns emerge among advocates of major infrastructural intervention in subsequent generations.

Dhaka's First Master Plan: Flood Mitigation through Strategic Growth

In 1956, two years before the EPWAPDA was established, the Dacca Improvement Trust (DIT) was founded to guide the planning and development of the city. In the years immediately following the partition of 1947, Dhaka saw an influx of refugees. During the decade from 1951 to 1961, the population of the urban region of Dhaka increased by 66% (Minoprio and Spencely, Dacca Improvement Trust, and Macfarlane 1979). To cope with this new growth, the DIT contracted with a London-based planning firm, Minoprio and Spencely and P.W. Macfarlane, to produce a master plan for the city. The "Report and Plans on the DIT Master Plan for Dacca" was issued in August of 1958.

Following the master planning conventions of the time, the Minoprio plan laid out a broad vision to guide the growth of Dhaka across a range of sectors, including transportation, land use, education, industry, commerce, and open space. Though the authors observe that "the great tide of refugees, which settled on the city after partition, has stopped," the issue of population pressure runs through the report as a motivating factor for state action, just as it had in both the Krug and IECO reports. While New Orleans' early planning efforts and infrastructural modernization plans, were seen as a means of spurring desirable growth and competitiveness, Dhaka's plans treated population growth as a problem, a tide of chaos in need of bureaucratic and infrastructural ordering. At the time of the report, the urban region had approximately one million residents, a number that the planners projected to increase at an annual rate of 1.75%[2]. The authors of the plan warned of the "evils" of "excessive growth of Dacca" and called for "national planning policy" to encourage decentralization.

The Minoprio plan identifies "the shortage of suitably located high land, free from annual flooding, on which to build" as the greatest challenge facing the city (Minoprio and Spencely and P.W. MacFarlane and Dacca Improvement Trust 1959). It describes the city as "hemmed in" by rivers and "restricted by wide tracts of low lying land." Even so, the plan included as one of its basic assumptions, "That no substantial alleviation of the annual flooding, which occurs during the monsoon season, will be possible." Remarkably, even as the Krug Commission and the IECO Master Plan advocated for building thousands of miles of flood control structures around the delta, the Minoprio plan does not even mention the possibility of structural flood protections for Dhaka. Rather, the plan foresees that the "land shortage" in Dhaka will be overcome through land filling, or "reclamation." The Minoprio plan projected that the relatively modest growth projected for Dhaka could be accommodated on existing

[2] This estimate would prove to be radically inaccurate as the population of Dhaka would actually grow at a nearly 10% annual rate between 1961 and 1981, partially fuelled by the rural violence associated with Bangladesh's independence struggle.

available high land "for at least the first 20 years." Sometime soon thereafter, major reclamation would be necessary to accommodate further growth. Because of this land shortage and the high cost of reclamation, the plan states that urban growth should be channeled to the relatively high ground to the north of the urban center of the time. "The future Dacca will, therefore, more and more take on the shape of an elongated belt some twelve miles long, with the old town as its broad base" (Minoprio and Spencely and P.W. MacFarlane and Dacca Improvement Trust 1959).

In the face of population pressure and land scarcity, the Minoprio plan also identified inadequate "open space" as a central planning challenge for Dhaka's growth. The planners echoed Patrick Geddes' concept of concentrating open space around a network of waterways. Chief among these waterfront open spaces was the Buckland Bund. The riverfront area first established in the 1860s had, in the intervening years, been overtaken by commercial and navigation uses. The plan called for creating an "amenity park strip of 17 acres" to "open up the river and form a fine open feature." To accomplish the task, they call for "the clearance of various untidy buildings" as well as removing market and boat landing facilities. This account, along with archival materials indicates that nearly one hundred years after its construction, the Buckland Bund continued to be a site of spatial contestation, seen by some as a rare urban waterfront amenity and by others as a crucial site of commerce and other activities.

Whereas the Krug and IECO reports included substantial visual materials, the Minoprio plan included just a single map depicting the "Area of Dacca Improvement Trust." The map is sparse, showing only basic road and rail infrastructure, major rivers, and shaded areas to indicate the location of Dhaka and Narayanganj settlement areas (Figure 3.8).

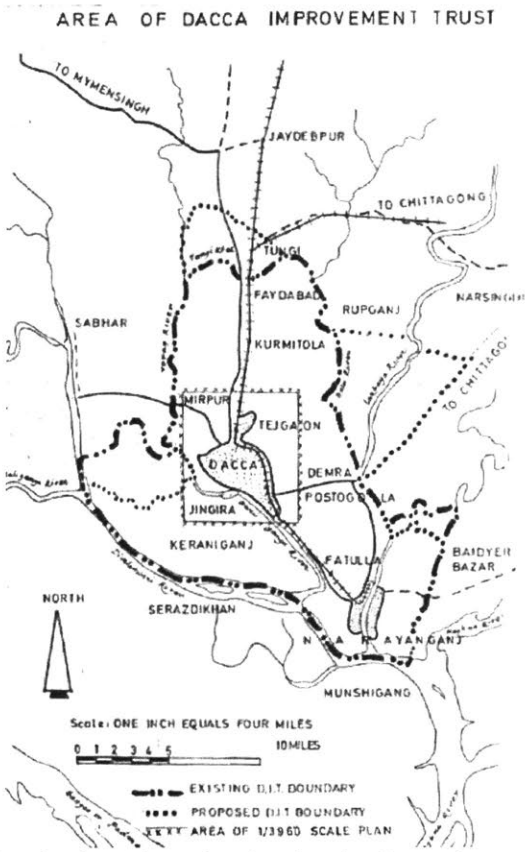


Figure 3.8. The only visualization in the Minoprio plan for the Dacca Improvement Trust (1958)

Infrastructural Modernization Plans for Dhaka

Much as Dhaka's population swelled with refugees following partition in the late 1940s and early 1950s, the years immediately before, during, and after Bangladesh's "Liberation War" saw an enormous increase in Dhaka's population. Where Dhaka had just over 550,000 residents in 1961, by 1971 the population was estimated at over 1.5 million and by 1981 it had increased to 2.2 million (Q. M. M. Zaman and Lau 2001). This rapid increase in urban population far exceeded the DIT plan's estimates, placing considerable pressure on the supply of developable land much early than anticipated. Whereas neither the province-wide water resource planning efforts for East Pakistan (Krug and IECO) nor the first master plan of Dhaka considered structural flood protections for the city, facing the rapid increase in urban population multiple studies conducted during the final years of the East Pakistan era called for constructing embankments around the city.

In 1968 a report known as the "Snell Report" by an American engineering firm proposed a combination of embankments, pump stations, and internal drainage improvements for a relatively small area of 75 square kilometers of central Dhaka. In 1970, the British engineering firm Sir William Halcrow and Partners conducted a study for a similar project. Following the conclusion of the Liberation War in 1971, the Halcrow proposal was expanded to include 100-year flood protection for an area of 250 square kilometers (Figure 3.9). The Halcrow proposal included both primary embankments along the major rivers around Dhaka and secondary embankments defining smaller polder areas within those primary protections. Each sub-polder was to be drained by mechanical pumping stations. For the first time in this proposal, Dhaka is conceived of as encompassing the entire ovoid area bounded by the Buriganga and Turag rivers on the west, the Tongi Canal to the north, the Balu and Shitalakya rivers to the east, and the northern edge of the DND embankments to the south. Though this area corresponds to neither planning boundaries, nor administrative boundaries, it has remained a powerful spatial imaginary in the planning of Dhaka's land use and flood control ever since.

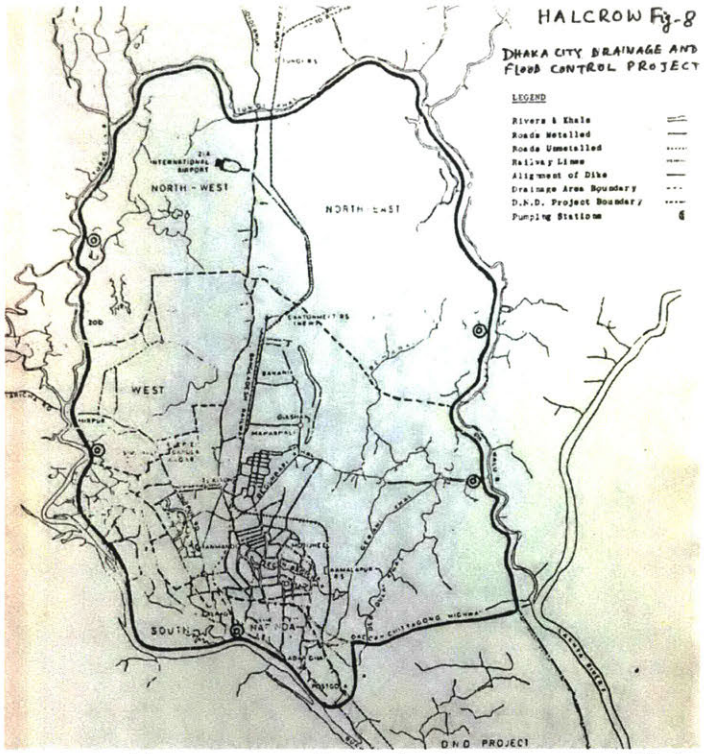


Figure 3.9. 1971 Halcrow proposal for encompassing embankments around Dhaka.

Through the early 1970s, the dominant approach to water infrastructure planning in Bangladesh remained largely aligned with the template set out in the Krug and IECO plans. In two reports from the years flanking the declaration of independence, 1970's "Proposal for an Action Program: East Pakistan Agriculture and Water Development" and 1972's "Land and Water Resources Sector Study Bangladesh," the World Bank continued the focus on improving agricultural production through investment in rural flood control, drainage, and irrigation projects. The 'Land and Water' study reaffirmed the position that "embankments afford the only practical means of flood control" and proposed investments in several embankment projects which had been proposed in the IECO Master Plan (International Development Association 1972). While the report observes that Dhaka is one of ten "principal towns [that] have flood problems," they justify their continued rural focus by saying "the urban population is rather low... and damages to dwelling house occur mostly to farms in small villages" (International Development Association 1972). The Mississippi River levees remained a key precedent for these projects, as the report includes graphs of river flows from the Mississippi River at Arkansas City and Vicksburg as an indication of how the delta's major rivers might react to embankment and other engineering manipulations.

In 1972, the East Pakistan Water Development Board (EPWAPDA) was divided into two separate authorities, the Bangladesh Power Development Board (BPDB) and the Bangladesh Water Development Board (BWDB). In the mid 1970s, the BWDB started construction on a ring embankment for Dhaka based on the Halcrow study. Beset by structural, managerial, and financial problems, the project succeeded in building only one-mile of embankment along the Turag River in the then-sparsely populated northwestern section of the city (Shankland Cox Partnership 1981b). No further work on embankments for Dhaka would take place for more than 10 years, though in 1974, a major flood impacted roughly one-third of the territory of Bangladesh and approximately one-quarter of Dhaka city. The flood, followed by drought, brought on a devastating famine to the delta. This same year, to cope with political challenges from both the left and right, Mujibur Rahman, the founding prime minister of Bangladesh (and father of the current prime minister) instituted first "Special Powers" in 1974 and then an "Emergency Period" in 1975 to broaden his powers through legislation and constitutional amendments. In 1975, Rahman was assassinated leading to 15 years of military rule, first under Ziaur Rahman and later Hussain Muhammad Ershad.

In 1979, the World Bank and the BWDB recommended the formation of the Master Plan Organization (MPO) to oversee high-level planning and coordination of water projects throughout Bangladesh. The MPO would go on to produce two National Water Plans (NWPs), one in 1986 and one in 1991. In the face of disappointing initial results from IECO projects and the advent of water scarcity concerns following the construction of India's Farakka Barrage, located up the Ganges in West Bengal, the NWPs generally de-emphasized major flood control works, instead recommending small scale irrigation projects. Though these plans continued to focus primarily on rural and agricultural issues, they did recommend the implementation of a flood control scheme for Dhaka city (F. Ahmed et al. 2015).

Against Comprehensive Flood Control: Planning in Post-Independence Dhaka

Over the course of the 1970s and early 80s, Dhaka continued to grow rapidly, from just over 1.5 million residents in 1971 to over 2.2 million in 1981 (Q. M. M. Zaman and Lau 2001). As the city grew throughout the 1970s, its infrastructure did not keep pace. As of 1981, there were only 15 traffic lights in the city (Shankland Cox Partnership 1981b). Drainage became an ever greater issue of concern, compounded by the expansion of settlements into surrounding low-lying areas, encroachment and filling of existing drainage canals, and drainage congestion caused by inadequate solid waste

management. Though the Department of Public Health Engineering undertook a piecemeal "crash programme" of piped drainage in 1976 and put forward plans for improving drainage in the city in both 1980 and 1981, seasonal flooding remained a problem for large portions of the city.

In response to a 1975 request from the BWDB for funding to construct the flood protection embankments proposed in the early 1970s by Halcrow, the ADB recommended that the flood protection proposal be integrated with a broader, long-term urban development plan. In spite of the rapid growth of the city, there had been no substantial planning for Dhaka in the years since the 1959 Minoprio plan. With the funding from the UNDP and ADB, London-based planning firm Shankland Cox undertook the Dhaka Metropolitan Area Integrated Urban Development Plan (DMAIUDP), with the explicit intent of integrating flood control planning with a broader urban growth strategy.

The DMAIDUP was developed in the context of rapid urban growth and growing infrastructure and service deficits. Much as the Minoprio plan had observed 25 years before, the DMAIUDP identified the "acute shortage of suitable land not subject to flooding" as a major constraint on urban growth and a driver for planning decisions. Though Dhaka's enormous growth had motivated various proposals for structural flood protection in the years between the two planning efforts, the DMAIUDP, like the Minoprio plan did not advocate major structural flood infrastructure investments. However, where the earlier plan had simply assumed that nothing could be done to alleviate flooding, the DMAIUDP actively considered proposals for "comprehensive flood control" in two of nine alternative urban growth strategies analyzed. In the end, the DMAIUDP's preferred growth strategies using land use controls and strategic investment in non-flood control urban infrastructure (e.g., transportation) to direct urban growth towards areas that were naturally less flood-prone. Some of the reasons cited for avoiding structural flood protection reflect a growing wariness of the aggressive form of infrastructural modernization that had guided water infrastructure thinking in the region since the Krug report in the mid 1950s.

Deploying the same rural development bias as the IECO and other previous studies, the DMIAUDP argues that investment in major flood control infrastructure for Dhaka would be too resource intensive given the government's "overriding national objective" of "accelerat[ing] rural development" and achieving "increased food production and higher rural incomes" (Shankland Cox Partnership 1981a). While the plan shared the focus on rural and agricultural development of previous planning processes, it also signaled significant shifts in the government's approach to infrastructure. In laying out the guiding principles for their planning process, the DMAIUDP team signaled a shift away from the previous generation of infrastructural modernization saying "there should be no proposals which involve long gestation periods, and which rely on high capitalisation, on advanced technology and on precisely scheduled programming" (Shankland Cox Partnership 1981a). Rather than the expert driven, capital-intensive, infrastructure-dependent model exemplified in the IECO plan, the DMAIUDP sought to model their urban projects on "the example of the rural irrigation projects successfully launched by President Zia," which relied on "massive mobilization of community and individual resources in self-help activities employing labour-intensive techniques" (Shankland Cox Partnership 1981a).

The DMAIUDP echoes many of the concerns raised in previous studies regarding the potential negative impacts of structural flood protections. The plan invoked the levee effect and the threat of catastrophic infrastructure failure, warning that a "comprehensive flood protection" scheme, "would involve the settlement of several millions of the urban population behind flood embankments under conditions where the risk of structural failure could never be completely ruled out." The planners argued against

embankments for Dhaka because, embankment-enabled growth in Dhaka "would be to expose the people living there to a risk not formerly faced" (Shankland Cox Partnership 1981b).

The DMAIUDP argued that, compared to comprehensive urban flood control, non-structural flood mitigation strategies would "require a lower level of resource allocation, a less critical timing schedule, and is more flexible in being able to adjust to future circumstances." This critique is aligned with the now-common view that structural flood protections are inflexible and that they tend to create "lock-in" or "path dependency" dynamics in which early decision to pursue structural protection create physical and institutional structures that favor further investments in structural measures (Staveren, Warner, and Khan 2017).

Rather than advocating for flood control infrastructure to enable growth, the DMAIUDP called for targeted investment in improving the drainage infrastructure of the city "to safeguard critical areas within the existing city." Like the Minoprio plan, the DMAIUDP also advocated for incentivizing limited growth at the periphery of the current urban core with further growth directed towards the relatively flood safe land to the north. After considering nine different development scenarios, the DMAIUDP concluded that "urban growth should be directed towards flood-free land in areas where there are not only opportunities for job-creation but also sufficient adjacent land for extensive residential development." They argue that this less infrastructure dependent model of growth would allow for the expansion of the city, "at a lower level of urban development expenditure with fewer implementation problems, and at lower risk than in the flood protection strategy" (Shankland Cox Partnership 1981a). In making the case against embankment-led urban growth models, the DMAIUDP pointed towards the shortcomings of the BDWB's previous urban embankment projects saying,

> Experience on recent urban embankment projects in Dacca has not been encouraging... Poor management, fragmented responsibilities, budget over-runs, excessive delays and, above all, structural failure are all signs of a serious lack of implementation capabilities. Any consideration of similar projects on a massive scale, tying up substantial capital investment over a long gestation period, must take into account the need for far-reaching reforms and improvements in project preparation and management (Shankland Cox Partnership 1981b).

Previous embankment proposals had recognized the need for institutional reform and increased capacity to realize the goals of infrastructure investment. However, the DMAIUDP planners' critiques make clear that serious institutional weaknesses remained. Imbued with a new sense of skepticism and preference for immediate and tangible gains, these planners were unwilling to simply recommend massive infrastructure investments and assume that the complementary institutional changes would develop. The DMAIUDP study also concluded through independent cost estimation, that the estimates included in the Halcrow proposal had been unrealistically low and could not "be safely used in any evaluation work on alternative growth strategies" (Shankland Cox Partnership 1981b). This underestimating of the costs of major infrastructure projects has since been shown to be a systematic feature of mega-projects across a range of geographic areas and infrastructure sectors (Flyvbjerg, Bruzelius, and Rothengatter 2003).

The DMAIUDP's plans are complemented by graphical illustrations that reinforce the plan's emphasis on urban spatial growth and infrastructure provision. The illustrations related to flood vulnerability and urban growth in the DMIAUDP are limited to a few hydrological diagrams and many maps at the scale of the urban region. In illustrations of Dhaka's historical urban growth, urbanization is depicted as a creeping tide of homogeneous black, growing over an ever-larger territory (Figure 3.10). The supporting study on flood protection that accompanied the DMAIUDP includes maps showing a McHarg-style

superimposition of different land characteristics (e.g., flooding, agricultural potential) to create a typology of "suitability for urban development" (Figure 3.11).

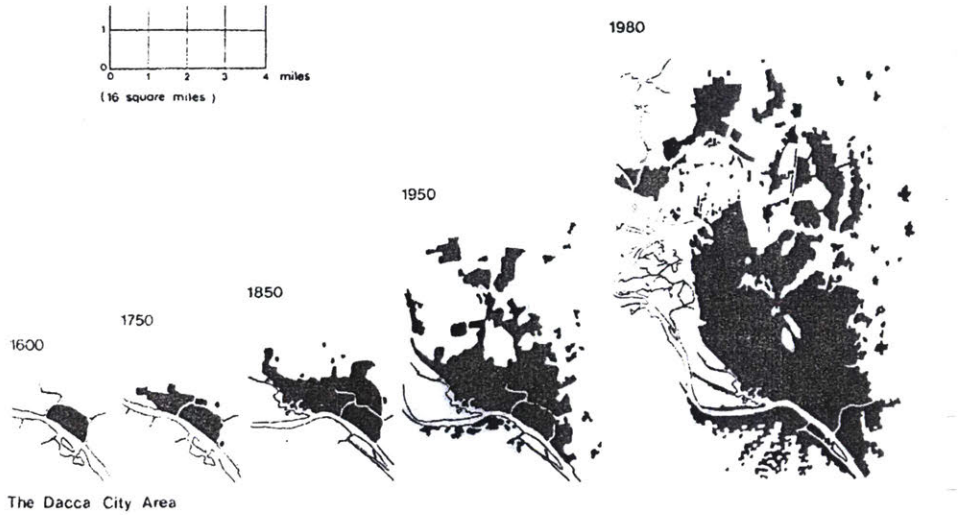


Figure 3.10. Urban growth maps from the 1981 DMIAUDP plan.

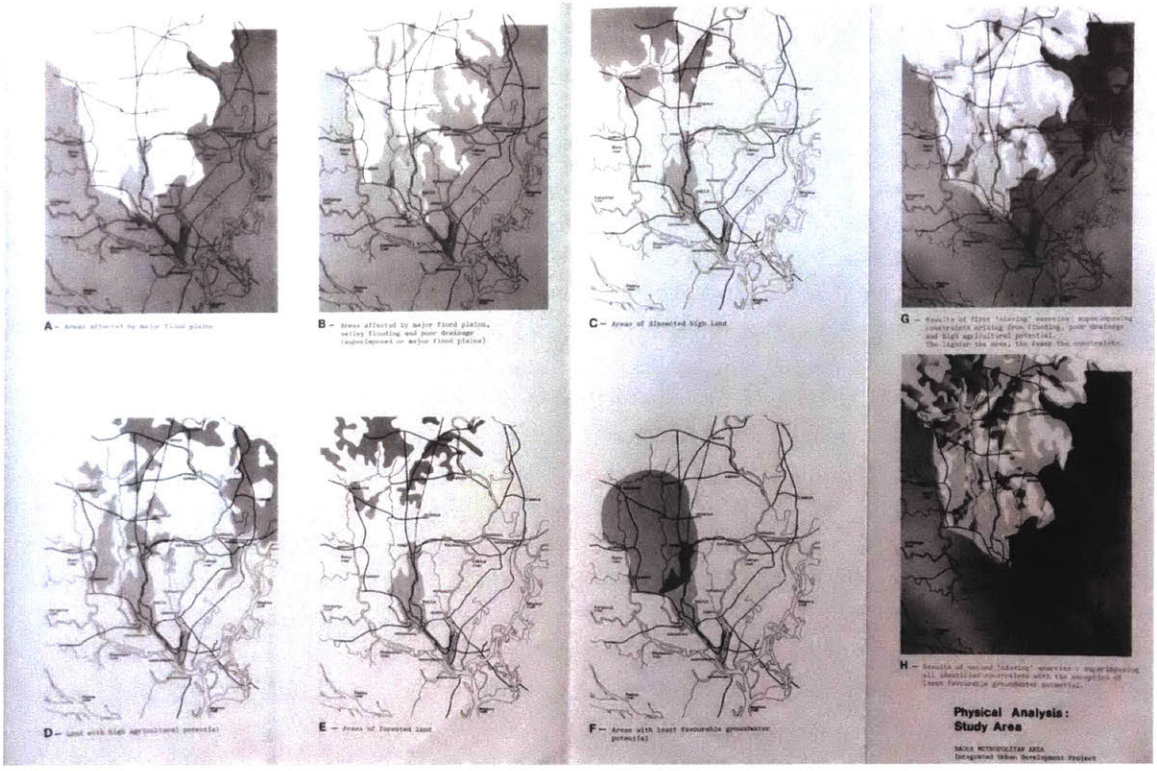


Figure 3.11. McHarg-influenced landscape suitability analysis from the 1981 DMIAUDP.

The Flood Action Plan: Crisis Driven Infrastructural Modernization

In the decade after the DMAIUDP, Dhaka continued to swell in population and area. The DMAIUDP planners estimated that the urban area including Dhaka had just under 3.4 million residents in 1980. By 1990, there were an estimated 6 million residents. In spite of this growth, the combined impact of political instability, resource constraints, continued bias towards rural development, and the growing

distrust of capital and time intensive infrastructure meant that neither structural nor non-structural flood mitigation strategies were substantially advanced for Dhaka in these years. While the DMAIUDP did have the intended effect of scuttling the previous plans for "comprehensive flood protection" for the city, authorities made very little progress in limiting development in flood prone peripheral areas as the plan recommended. New infrastructure investments did spur intended growth along the northern corridor. However, unplanned and underserviced growth also spread into lowlands to the east and west of the main planned development corridor.

When two successive years of heavy flooding swept through the delta in 1987 and 1988, the combined effect of minimal investment in drainage and flood control and the virtual absence of development control meant that the flood impacts in the city were severe. The 1988 flood, inundated an estimated 85% of the city area and affected 60% of the population (Huq and Alam 2003). During the weeks of high water in September 1988, embankments in the flooded regions became sites of feverish activity. Improvised crews of local residents worked to reinforce dikes, hoping to save their homes and lands.

As the worst of the flooding passed and the waters began to recede, rival narratives emerged attributing blame to various actors and causes and advocating alternative paths to reduce future flood vulnerability. The president repeatedly invoked the need for a "permanent solution to [the] flood problem," saying that "the nation could not accept the situation any more" (*Bangladesh Observer* 1988c). A September 11, 1988 editorial in the *Bangladesh Observer* similarly argued for "a viable answer to floods," "something substantial on engineering or specialised other lines" that could "tame or train the rivers and thus minimize the seasonal suffering caused by the floods" (*Bangladesh Observer* 1988b).

Though many sought structural interventions to "solve the flood problem," others saw failed planning and regulation as the cause of the flooding. An editorial from September 9, 1988 made this case saying,

> there can be little doubt that our tampering with the city's topography, our senseless pursuit of building plots, the haphazard lay-out of the new roads, the numerous obstructions we have created to the free movement of water, have given rise to a problem which cannot be blamed on nature (*Bangladesh Observer* 1988a).

For these observers, the key to addressing the city's flood problem would not entail new flood control infrastructure. Rather, they argued for land use control and drainage improvements of the type advocated in previous plans, from Patrick Geddes' survey, to the Minoprio plan, to the DMAIUDP. Some saw such adaptive urban form and canal-based drainage as a return to tradition. A September 16, 1988 editorial argued that "pumps are no solution at all" and that, "To save the city we have to go back to the Dhaka that was planned and built with an elaborate canal system with its branches running across the city" (*Bangladesh Observer* 1988e). Another editorial argued that infrastructural modernization projects had "created more problems than solved them, both in cities and the countryside" and that solutions lie in a "country wide drainage system being remodelled on traditional lines" (*Bangladesh Observer* 1988b).

This rejection of the engineered solutions associated with regimes of international expertise resonated with the post-colonial nationalism of the time, emphasizing smaller-scale solutions, appropriate technology, and self-reliance. In the wake of the floods, Ershad lamented that the floods had "nullified" development efforts just as "the nation was marching on the path of progress" and that "the people of this country want to stand on their own feet by putting in hard work and they do not want to depend on others" (*Bangladesh Observer* 1988d). A letter to the editors of the *Bangladesh Observer* argued that,

> We must have some dignity and resolve as a nation that we either solve the problem or we survive with flood but not with relief aid. Mr. Editor, can we swear as a nation that next year whatever may come we shall neither expect nor accept any foreign aid for flood. This kind of

> resolution will give us the mental strength which is needed for us to survive as a dignified nation (*Bangladesh Observer* 1988b).

In the contentious political climate of the time, the floods became a rallying point both for the ruling military regime and the opposition party leaders. Sheik Hasina, who would eventually be prime minister and who is the daughter of Bangladesh's first leader, took the opportunity of the flood to question the legitimacy of the ruling authoritarian regime, saying, "only a representative government can solve this problem" (*Bangladesh Observer* 1988f). Ershad countered by invoking crisis to quash political opposition, saying that in the time of emergency, "there was no other politics in the country... other than the politics of serving the suffering humanity and reconstructing the damage" (*Bangladesh Observer* 1988d).

The extreme floods of the late 1980s put into motion a series of events that would radically reshape flood infrastructure planning in both Dhaka and the wider national territory. The floods notably shifted the framing of flood infrastructure planning for Dhaka from a primary focus on how to *accommodate urban growth* given the city's low lying terrain to an urgent focus on providing *protection* and reducing flood *vulnerability*.

Immediately following the 1988 floods the president formed the "Committee for Flood Control and Drainage of Greater Dhaka" chaired by the Minister of Planning. From its outset, the committee was charged with creating a "flood control plan," clearly indicating that the old resistance to infrastructural intervention was no longer at play. In addition to creating the flood control plan, the group was also tasked with integrating consideration of "link roads," "modernization" of the sewerage system, and creation of lakes within the city to 'facilitate drainage" (Committee for Flood Control and Drainage of Greater Dhaka 1989). The Committee issued their report in January of 1989 calling for an embankment-based flood protection program in line with that proposed by Halcrow in the early 1970s. It also embraced the drainage plans recommended by a 1987 Japan-funded study. The Committee incorporated the findings of TGH Jansen, a Dutch flood expert who studied the flooding patterns and made recommendations for infrastructure investments. The report included Jansen's maps showing the extent of flooding in Dhaka city as an opaque black scrawl over much of the city (Figure 3.12). In reviewing previous plans for the city, the Committee simply observed that the DMAIUDP included "no detailed flood control and drainage plan" and did not comment on the role of land use controls at all (Committee for Flood Control and Drainage of Greater Dhaka 1989).

Figure 3.12. Jensen's map of Dhaka flooding from the Flood Commission report (1989)

The report built off of previous infrastructure studies to propose full embankments for Dhaka city and large areas of the surrounding floodplains. In the words of the Commission,

> the proposed flood control scheme is to construct a dam alongside the surrounding rivers and to form a number of protected (polder) areas, each approximately the size of the DND polder within a primary embankment. Drainage from the polders will be facilitated by a number of pumping stations (Committee for Flood Control and Drainage of Greater Dhaka 1989).

The primary focus of the Committee report is on initiating an emergency "crash programme" of embankment construction. Like previous generations of flood infrastructure planners, the Committee invoked both urgency and inevitability to motivate prompt action and to circumvent regular procedural and political obstacles. Though the report was issued only in January 1989, the Committee recommended that work commence on the first embankment construction along the Turag and Buriganga Rivers to the west of the city as early as February 1, 1989 with the goal of having substantial infrastructure in place by the time of the summer monsoon. They referred to the construction of "a flood protection structure alongside the surrounding rivers" as an "inescapable step," invoking previous embankment studies by Halcrow and Jansen.

While the primary focus was on the flood protection function of the proposed embankments, the Committee also saw this emergency program as a means to promote modernization through new road construction and to facilitate urban growth. They argued for the construction of major roads along the embankments "for the purpose of by-passing the city traffic." The Committee argued that rather than building embankments to protect only the currently urbanized areas, building them "closest to the surrounding rivers would be clearly better option than to go for intermediary embankments and

abandoning them at a later stage." Balancing this desire to enclose the maximum area for future urban growth with the need for timely and cost-efficient action, the Committee recommended that the more heavily urbanized western portion of the city be empoldered on a "crash" basis with the central thoroughfare Pragati Sarani being elevated to serve as a temporary eastern edge of the polder until the eastern embankments could be built at a later stage (Figure 3.13).

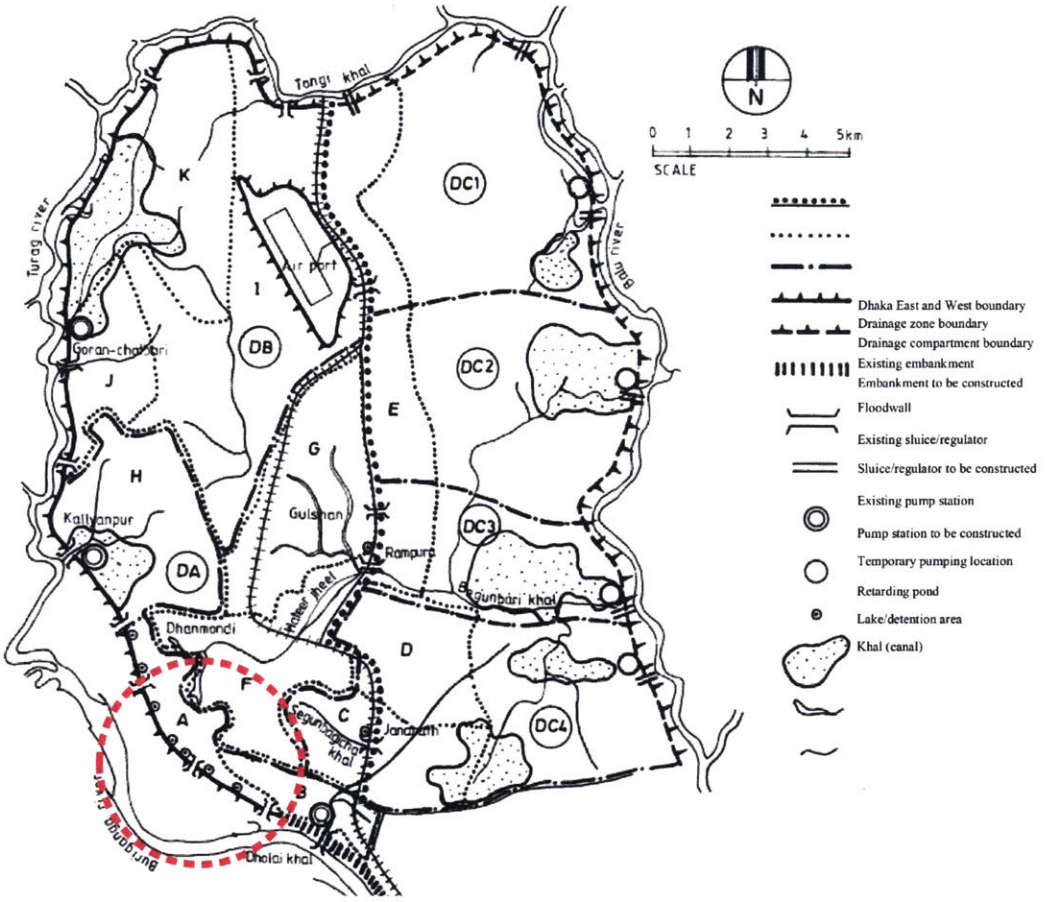


Figure 3.13. The FAP 8b proposal for Dhaka's embankments, including improvement of the "crash programme" embankments in the west and future poldering in the east. Kamrangichar was excluded from the western embankment (1991).

Though the Committee fully embraced embankments and pumped drainage as the inevitable solution to Dhaka's flood challenges, there still lingered a sense of unease about fully severing the ties between the city and the surrounding waterways. They argued that

> water of normal flood level should be allowed to enter the low lying areas of the Dhaka City. It would not be prudent to close greater Dhaka totally from normal flood water without thorough and in depth study (Committee for Flood Control and Drainage of Greater Dhaka 1989).

The crash program included the construction of several sluice gates intended to remain open during normal conditions, but to be closed when water levels in surrounding rivers reached flood stages.

In the months after the Committee's report was issued, a coalition of municipal and national government agencies led by the Army initiated the crash program to build embankments around western Dhaka. Many aspects of the report would serve as guideposts in setting conditions for future urban flood infrastructure in Dhaka even to this day. The report and the infrastructure that it enabled

launched a new reliance on embankments and pumped drainage and signaled a shift away from land use control as the primary tool for reducing flood risk. The report's linkage of urban growth and transportation to flood infrastructure also continues into the present. Though the Committee called for caution in severing the hydrological connections between the city and its surroundings, the infrastructures that were built did indeed lead to a substantial severing, causing massive disruptions to water-based livelihoods and extensive waterlogging inside the protected zone (Adnan and Ghani 1991).

As the Committee considered how to respond to the 1987 and 1988 flooding of Dhaka, a larger process unfolded involving an array of government, NGO, and development actors in formulating a plan in response to the flooding at the national scale. Immediately following the 1988 floods, experts mobilized by several governments including those of Bangladesh, France, Japan, and the USA, each initiated studies for addressing Bangladesh's flood vulnerability. The French study called for construction of massive embankments and river training works on the major rivers in the country (Consortium and others 1989). The Japanese team called for some poldering and extensive investments in forecasting and warning systems, but also cautioned against long continuous embankments on the major rivers (Hughes, Adnan, and Dalal-Clayton 1994). The study funded by USAID, which came to be known as the "Eastern Waters Study" was skeptical of major flood control infrastructure on the grounds that such structures were neither economically justifiable, nor technically possible given the power of the delta's rivers (Rogers, Lydon, and Seckler 1989). The Government of Bangladesh (GoB), working with the UNDP recommended a program of extensive river embankments and compartmentalization in line with the IECO study of more than 20 years before. The GoB report included a statement of "Eleven Guiding Principles" for flood mitigation. Though the principles reflected some of the same ambivalence and caution regarding structural protections that appeared in the Japanese and USAID studies, it placed embankments at the center of its strategy, defining one of the foundational goals as, "Safe conveyance of the large cross-boundary flow to the Bay of Bengal by channeling it through the major rivers with the help of embankments on both sides" (Hughes, Adnan, and Dalal-Clayton 1994).

The World Bank took on a coordinating role among the many international agencies and convened an donors conference in London in December of 1989. The "Action Plan for Flood Control" that framed the discussions at that conference acknowledged all of the previous studies and the concerns and cautions raised therein, but it adopted the Guiding Principles set out in the GoB study as prerequisite, thus embracing the central role for embankments. Under World Bank leadership, what became known as the "Flood Action Plan" (FAP) included twenty-six components, each funded and lead by one or more international donors. The World Bank estimated that the initial five years of the FAP would see $5-10 billion in studies and infrastructure projects.

Of the twenty-six components, eleven were "main components" and fifteen were defined as "supporting studies." Both the studies and the projects reflected the diversity in strategies for flood mitigation signaled in the preliminary studies, embracing both *structuralist* and *behavioralist* orientations. FAP components included a range of foundational knowledge and institution building such as studies of fisheries (FAP 17) and environmental conditions (FAP 16), topographic mapping (FAP 18) and GIS mapping (FAP 19), and a river survey (FAP 24). Another set of projects embraced behavioralist and non-structural approaches to flood mitigation including disaster preparedness (FAP 11), cyclone preparedness and shelter construction (FAP7), flood forecasting and warning (FAP 10), and flood proofing (FAP 23). Along with these studies and non-structural projects, the FAP included several ambitious structural flood protection projects including a Dutch/German led "compartmentalization pilot project" (FAP 20) to construct large polders in the Tangail region north of Dhaka and an

ADB/Japanese (JICA) funded effort to plan and build protective infrastructure around Dhaka city (FAP 8a/8b).

FAP 8a/8b: Dhaka City Protection

Though many of the FAP projects focused on rural and agricultural areas, the flooding of wealthy neighborhoods and diplomatic enclaves in Dhaka pushed leaders to prioritize structural protections for the growing capital city. As discussed above, President Ershad authorized a "crash program" of embankment construction for the urbanized areas of western Dhaka beginning just a few months after the 1988 floods. Though previous plans for the city had advocated land use-based flood mitigation, the crash program put in place dry city infrastructures including earthen embankments and concrete floodwalls along with sluice gates and mechanical pump stations. Following on these preliminary constructions, two FAP components--FAP 8a and 8b--laid out plans for flood protection for the city. Funded by JICA, FAP 8a, put forward a plan for flood control and drainage for the larger urban region including both eastern and western Dhaka as well as the surrounding areas of Savar, Tongi, Narayanganj, and Keraniganj (Japan International Cooperation Agency 1991). FAP 8b, funded by the ADB and overseen by American consulting firm Louis Berger International, Inc., included plans for remediating problems with the crash program embankments to create a permanent system of levees, sluices, and pumps for western Dhaka.

FAP 8b: Reinforcing the Crash Programme

Starting in January of 1991, the team from Louis Berger International and its associated local subcontractors set to work to generate a plan for flood control works for the urbanized western portion of Dhaka city, bounded by the Turag and Buriganga Rivers to the west, north, and south, and by Pragati Sarani to the east. The FAP 8b report issued in September 1991 was entitled "Dhaka Integrated Flood Protection," gesturing at the continued rhetorical value placed on integrated planning for flood infrastructure. Like previous flood planning efforts, the Berger team acknowledged many of the negative impacts of structural embankments and called for improvements in planning and land use controls. Even so, their report embraced the basic elements and alignment of the crash program's infrastructure. The FAP 8b study relied on several new rationales to justify its work including, remediation of existing infrastructure deficiencies, economic benefits from urban expansion, poverty alleviation, and improving urban environmental conditions.

The FAP 8b team largely did not engage with the question of whether structural protections were a wise investment for Dhaka. Rather, they accepted that the crash program's embankments as a fait accomplit, fundamentally shifting the conversation about flooding in the city. In fact, the main report from FAP 8b cites the deficiencies of the hastily built embankments as creating an increased flooding threat for the city that must be urgently "remediated." It states that the crash program was,

> started without a proper feasibility study and site investigation, and construction was done under extremely tight time constraints without adequate quality control or adequate scheduling and coordination of interlinking activities. (Louis Berger International 1991)

As a result, major areas of the embankments had already failed within their first year of existence. The report estimates that some 37% of the new embankment was "unstable and potentially subject to failure" and that 16% was "subject to catastrophic failure" (Louis Berger International 1991).

In addition to remediating the problems with the crash program embankments, the FAP 8b report cited several other new and familiar rationales. Joining discourses of flood security to those of economic growth, poverty alleviation and environmental improvement, the report lists the primary objectives as, "to provide flood security in Dhaka City to improve urban efficiencies and environmental conditions, particularly for the urban poor, and to promote sustainable long term economic development."

Though the report places great rhetorical emphasis on the importance of improving the living conditions of Dhaka's poor, it did not recommend changing the existing alignment of the embankments built under the crash program even though that alignment excluded major urban poor settlement areas along the Buriganga River. Maps included in the project report show Kamrangichar and the area to its north outside of new protective embankments (Figure 3.13, above). In 1991, the year of the FAP 8b report, Kamrangichar alone was home to over 25,000 residents, most of whom lived in informal settlements.

While the proposal included strong rhetorical emphasis on poverty alleviation and environmental improvements, the primary benefits used to justify the project were related to land value appreciation and enabling urban growth. The report states that,

> the major economic and financial benefit from the Flood Protection and Drainage programs of the Project will be the expected increase in land values for low lying -and medium elevation - areas which are subjected at present to regular and periodic flooding. Flood protection and control will lead to an expansion of Dhaka's economic infrastructure in the form of residential dwellings, industry and other types of real estate. These benefits, which can be estimated by projected increases in land values, appear to be significantly greater than Project costs.

Though the report predicts that new embankments will enable land value appreciation and urban development "because low-lying areas will not have to be raised as much as previously to prevent damage from normal flooding." In this rationale, the embankments serve as crucial component of a public-private "growth machines" (Logan and Molotch 1987), paralleling the rationale for dry city infrastructural modernization in 20th century New Orleans.

The "growth machine" dynamics described by Logan and Molotch rely on the alignment of private incentives for profit from urban growth with the incentives for public actors to seek increased tax revenue. In the case of Dhaka, the public sector institutions responsible for urban infrastructure and development were radically limited in their capacity to recover the costs of infrastructure through taxation and fees. Thus, in line with the priorities of the World Bank and other international aid organizations of the time, the FAP 8b report dedicated considerable attention to institutional reforms to improve 'cost recovery.' The report acknowledges that direct cost recovery for flood control infrastructure is difficult because flood protection is generally considered to be a non-excludable public good. As such, they argue for the strengthening of a range of taxation and fee collection mechanisms to enable the government to capture the value created by investments in flood control infrastructure.

Like previous flood infrastructure planning reports in Bangladesh, the FAP 8b report acknowledged the down side risks of structural flood protection and indicated the essential role played by complementary institutional and non-structural flood mitigation measures. The report recognized the danger of a levee effect brought on by "induced in-migration" into newly "flood free zone," creating "potentially disastrous impacts of a breach" that "could be worse than the current situation" because of the "sudden and unexpected" nature of such a flood in areas with "a false sense of security." Among the negative impacts expected to occur inside the embankments the report lists drainage congestion, worsening water pollution, and transportation impacts from the disruption of existing canals. In fact, at the time of the writing, the authors reported so-called "public cuts" or sabotage of the existing embankments, "apparently in protest by local people over routing, severance and isolation of communities, commercial establishments and residents." Though the report acknowledges the public cuts as a form of protest, it indicates no substantial plan for public outreach or participation, stating that "there are no explicit requirements for public meetings related to the work effort, or mechanisms described for receiving public comment on its various aspects." The report also recognizes the potential maladaptive impacts of

new infrastructure on those areas outside of the new embankments where residents were concerned that they would be subjected to increased flooding because of the new infrastructure. However, here again the report offers no significant solutions for the "excluded communities," rather it anticipates that many such impacted people will simply "migrate into the protected areas and even build residences on the embankment."

In order to address these potential negative impacts, the report calls for wide ranging institutional reforms and capacity building. The report calls for reforms to the BWDB to emphasize the ongoing responsibilities of operations and maintenance. It also explicitly linked the projected benefits of the new flood control and drainage infrastructure to the need for complementary improvements in land use and development control. It recognized that the "serious drainage problems" in Dhaka were largely caused by "unregulated and uncontrolled urban growth." As such, the report states that "developing appropriate land development standards, regulations and control mechanisms/procedures" was essential to "ensure that the investment in improved flood control and drainage facilities" are "not negated by uncontrolled and unrestricted growth." Among the specific areas of concern for improved land use controls noted in the report are canals, retention ponds, and the recommended 50-meter right of way needed to build the ring road along the embankment. Without improvements in spatial governance, these areas, which were essential to the functioning of the new dry city infrastructures, would likely be overtaken by uncontrolled urban growth.

While the FAP8b report recognized that infrastructure investments must be complemented with institutional reforms to improve land use controls and operations and maintenance, the vast majority of the resources called for in the budget were dedicated to the design and construction of the infrastructure itself. In the end, the recommended institutional investments and reforms in the plan languished, while investments in construction proceeded.

Like previous engineering proposals, the illustrations of proposed infrastructure in the FAP 8b report are simplified infrastructure sections and urban scale plans. Several simple line drawings depict the standard sections for embankments and floodwalls to be remediated under the plan. These sections show the critical dimensions and grading of the embankments, but they do not typically include any indication of the context of the infrastructure, suggesting that the embankments will be built in an undifferentiated and blank field (Figure 3.15). The one exception is a section showing a "Typical Cross-Section for Extension of Floodwall in Old Dhaka West Area." This drawing indicates the location of the river by a single horizontal line and the location of adjacent "Existing High Density Development" with a rectangular cross-hatched area (Figure 3.16). Even when the report's illustrations acknowledge the urban context, they do so in radically simplified, schematic, and static form, ignoring the interaction between the infrastructure and the dynamic nature of the urban and hydrological environments.

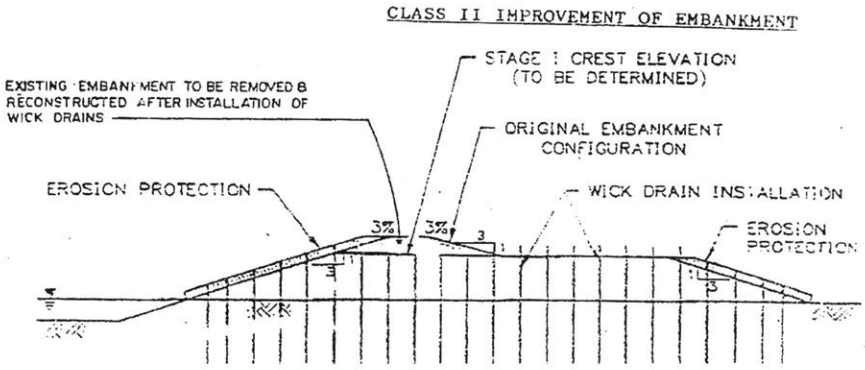


Figure 3.14. Typical embankment section diagram. FAP 8b (1991)

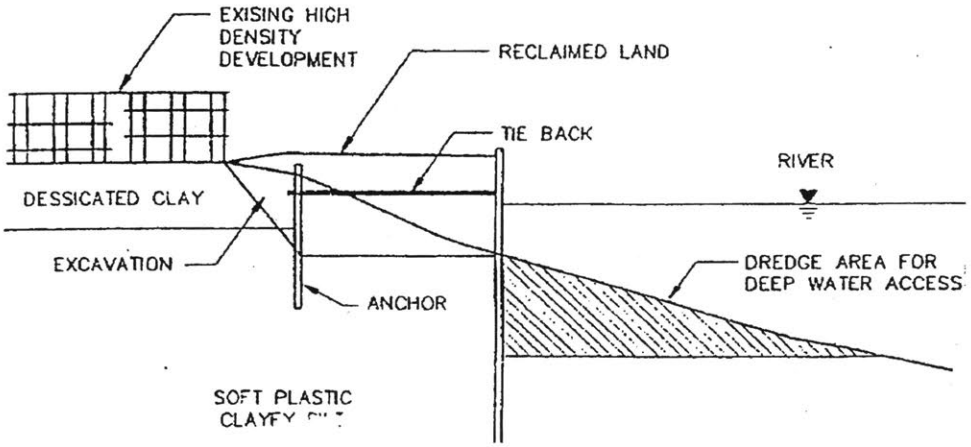
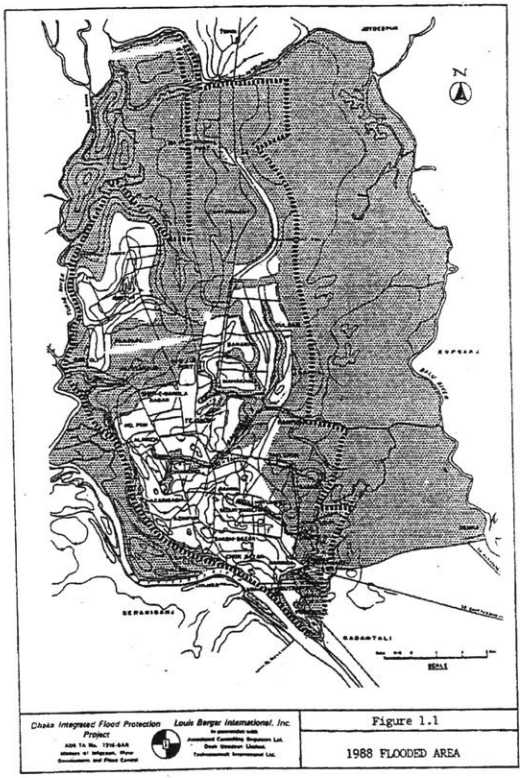


Figure 3.15. Typical floodwall section in urban area. FAP 8b (1991)

All of the maps included are at the scale of the urban region and all reinforce the concept of that region as defined by the area between the Turag and Buriganga Rivers on the west and the Balu and Lakhya Rivers on the east. This conception of the urban region radically simplifies and ignores the vast and growing areas of urbanization that existed even at this time beyond these riverine boundaries. The plan's first image shows the "1988 Flooded Area" as a binary of flooded and non-flooded territory making no indication of depth, duration, damage, or any other relevant context. The hatch indicating the flooded area on the map also ends abruptly at the rivers, though the actual flooding was at least as severe in the areas across the rivers (Figure 3.17). The maps also reify the distinction between the urbanized west and the less settled eastern portion of the city (Figure 3.18). The maps show new and upgraded infrastructure at the scale of the urban region through simple graphical symbols and hatches. Embankments appear as a line of dots or triangles reminiscent of advancing fronts on weather maps or the lines of control on a battle plan. Figure 1 of the report shows the "project works" proposed in the report, clearly indicating the persistent exclusion of the areas on and upriver from Kamrangichar. The map also shows the territory defined for "slum, solid waste, sanitation, etc area improvement" as a uniform hatch over the entire southern portion of the newly empoldered area. This categorization links informal settlements to waste and sanitation problems. Nowhere in the illustrations or the text, does the report indicate where exactly these investments were to take place.



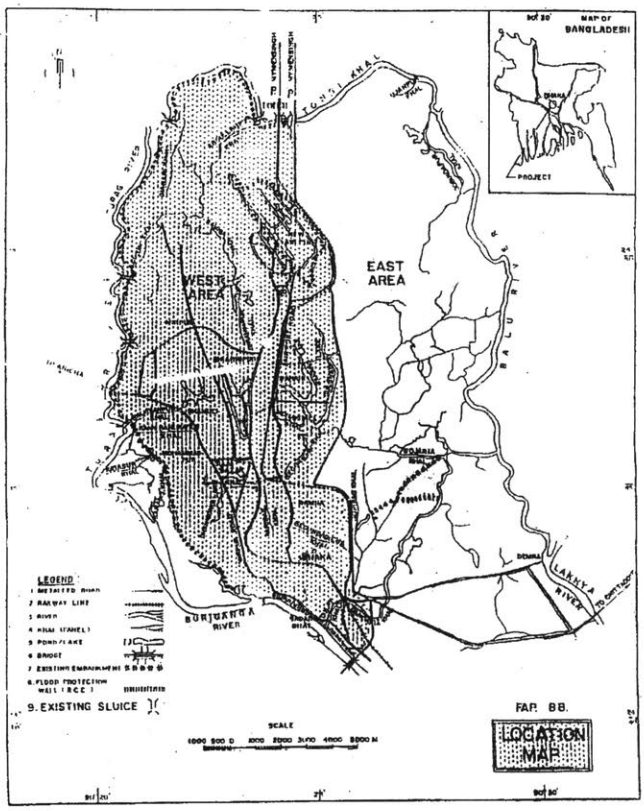


Figure 3.16. Left: "1988 Flooded Area" from FAP 8b.
Figure 3.17. Right: West-East areas from FAP 8b.

The report's illustrations emphasize investments in embankments, floodwalls, drainage pipes, and canals over the other aspects of the program aimed at poverty alleviation and environmental improvement for the urban poor. The illustrations underline the extent to which the embankment planning process was guided by a radically simplistic conception of the context.

FAP 8a: The Grand Vision

While FAP 8b focused on the immediate remediation and upgrading of flood and drainage infrastructure in western Dhaka, FAP 8a took a larger scale and longer term view of flood protection for the city. The final FAP 8a report, entitled "Master Plan for Greater Dhaka Protection Project (Study in Dhaka Metropolitan Area) of Bangladesh Flood Action Plan No. 8A" was released in November of 1991. The plan laid out an ambitious program of structural flood protection and drainage improvements for the wider territory, including the adjacent areas of Tongi, Savar, Keraniganj, and Narayanganj. Like the FAP 8b report, the FAP 8a report emphasized security, growth, and improving conditions for the urban poor in making the case for new flood infrastructures. Also, like the other report, FAP 8a acknowledged the limitations of structural flood protections and discussed essential complementary non-structural strategies. Both reports proposed structural measures that required major changes in institutions and spatial governance rather than designing strategies that could work with the existing conditions and constraints present in Dhaka.

The overall framing of the FAP 8a report tied together the language of security, urban and economic growth, and poverty alleviation. The report stated that its overall goal was, "to eliminate flood and drainage problems and to enhance the security of people" in the study area, which planners defined as

"extremely vulnerable to floods and inundation" (Japan International Cooperation Agency 1991). To this end, the plan called for building off of the "Phase I" infrastructure proposed in FAP 8b to keep "the major part of Dhaka City" "free from external floods." Though the plan did not consider alternative alignments for western Dhaka, it did propose to extend levee protection to enclose Kamrangichar, the fast growing area of riverside informal settlements that was excluded from the FAP 8b embankments. The plan also called for a series of "independent" compartments or polders to protect eastern Dhaka as well as the adjacent towns in the study area.

The plan sought to anticipate and facilitate future urban growth through structural flood protections. The authors observed that "the urban area is expanding into surrounding low-lying areas" and that embanking these areas would require significant investments in stormwater retention and mechanical pumping. The proposed strategies were meant, "to protect not only existing urban areas, but also the forecast future urban development areas in 2010, by structural measures against the flood of a 100-year flood frequency." Like FAP 8b, the FAP 8a justified the expense of this infrastructure expansion on the basis that it would increase development potential and property values, saying "The project enhances the land use potential of 166 km2 of habitual flood area for urban, industrial, agricultural and other uses, which will be reflected by increased land value in short term."

The FAP 8a project promised not only growth, but *planned growth*, a promise with special allure for officials in Dhaka, a city that had long been regarded as hopelessly chaotic. The FAP 8a plan claimed that, "The opportunity for planned urbanization with due flood mitigation and drainage improvement is a major advantage offered by this project." Where generations of plans and land use and building regulations had been unsuccessful in bringing socio-spatial order to Dhaka, the FAP planners promised that the investment in embankments and pumps could finally deliver the orderly environment leaders so desired.

As with the FAP 8b reports, the FAP 8a plans argued that expanded flood protections for Dhaka would enable greater equity and alleviation of the suffering of the city's poor residents. The plan cited the "unfairness of urban land allocation between rich and poor" in which "the poor 70% majority has access to only 20% of the city's land." It further argued that "only when substantial quantities of land are made available for the poor will densities in poor areas stop increasing" and made the case that the plan's levee and pump projects were the means to create these lands. The FAP 8b report presented the alchemical potential of land reclamation as not only a means of enabling growth and prosperity but also a tool for achieving more orderly and equitable development.

While the FAP 8a planners argued that their proposed levees would deliver major benefits, like previous water infrastructure modernization proposals in Bangladesh, the proposal relied on very optimistic assumptions regarding transformations in water bureaucracies, land use controls, and other governance functions. Arguing that "long range planning requires some degree of optimism," the plan assumes "that more efficient land acquisition and servicing mechanisms will be operational by the year 2000, with substantial areas now being made available for all income groups." The FAP 8a plan explicitly discusses the need for new land use controls in conjunction with the new embankments and points to the subsequent Dhaka Metropolitan Development Plan (DMDP) process as the means to provide this new regulatory framework. It lays out the scheme of zoned building and land use restrictions, including "flood flow zones," where "land development for residential, commercial, and industrials should be prohibited," and "sub-flood flow zone" in which development "is to be controlled by the Government" (Figure 3.19). The plan also calls for the DMDP to provide a means of "regulating ponds and khal areas as planned and to assure the required elevation of new land development."

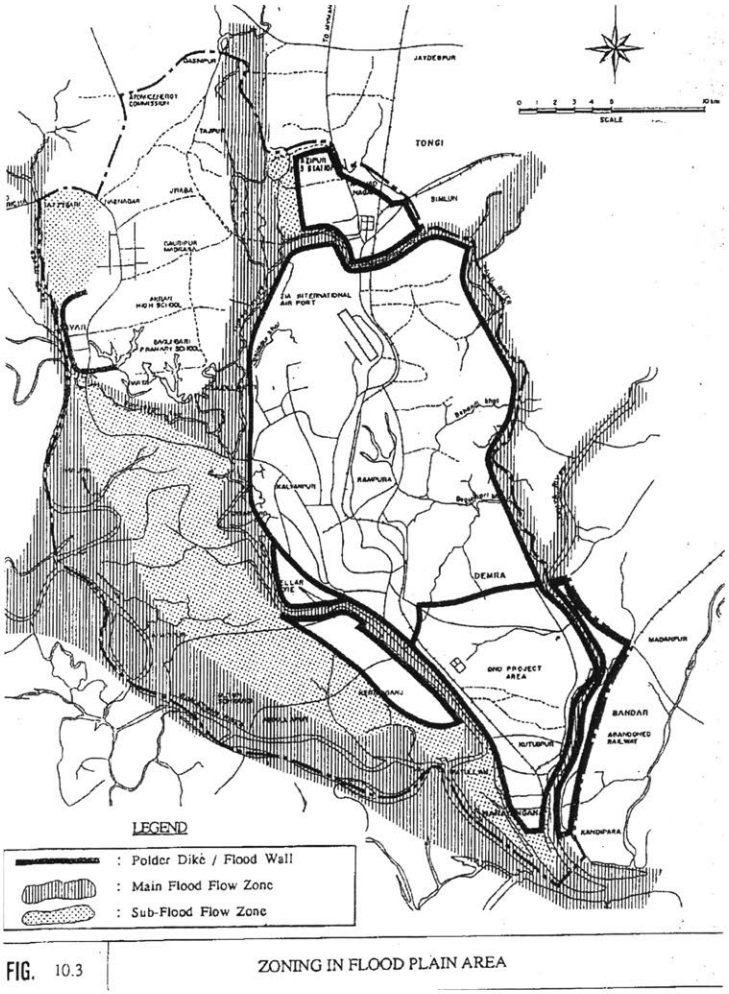


Figure 3.18. Floodplain zoning proposal from FAP 8a Master Plan.

To deliver on the transformations that they promised, the FAP 8a plan argues that not only would the city's spatial governance need to be revolutionized but also that the "capacity" and "culture" of the institutions responsible for the infrastructure must be radically remade. To avoid the levee effect, the plan argued that there must be improvements in operations and maintenance (O/M), saying

> Inadequate O/M and the consequent failure of the flood mitigation facilities could lead to even greater damage to life and property than there would have been without the facility. Once completed, the embankment will encourage people to settle in areas where formerly they would not have settled because of high risk of flooding.

The plan makes the case that, to achieve the necessary institutional changes will require, not only increased technical capacity, but deeper cultural and behavioral change, saying

> Proper O/M can only be done when everybody involved develops an attitude of personal responsibility for the work being done. Training can be given not only regarding skills, but also to change behavior.

The FAP 8a plan proposed a massive program of infrastructural investments to remake the relationship between Dhaka's urban lands and the surrounding floodplain. The planners argued that the hundreds of kilometers of new earthen embankments linked to new pumps, pipes, canals, and retention areas would

remake the city, bringing economic prosperity, greater equity, and more control over chaotic and disordered spatial development patterns. While the plan focused primarily on investments in physical infrastructure, it also made clear that, for those infrastructures to deliver on their promise, they must be paired with transformative change in administrative systems, spatial governance practices, and even the behavior and culture of many central institutions. This tendency to pair proposals for infrastructural investment with disclaimers about the essential nature of associated (but unfunded) institutional and cultural change, continues a pattern from the earlier generations of infrastructural modernization in the Bengal delta. From the IECO Master Plan forward, consultants and experts advocated for investments in hard infrastructure whose success was deeply reliant on altering cultural practices, institutional capacities, and governance regimes. Like other plans before and after, the FAP 8a plan repeatedly invokes a sense of impending crisis as a reason to forge ahead with infrastructure projects in the face of projected problems. The plan invokes the language of violence and threat, and argues that the state must act to safeguard Dhaka against floods, saying,

> the fundamental question is if Dhaka, the capital of Bangladesh, with a population expected to surpass thirteen million before the end of the project period, can be left open to recurrent attacks of natural calamity by debilitating floods. Flood protection of settlements is a basic need which should, and can only, be addressed by Government.

FAP Critiques

While the FAP projects were marked by an ambiguous relationship to structural flood protection, it is these structural components that have come to define the legacy and popular response to the FAP. From early in the FAP process, activist NGO's, academics, and journalists in Bangladesh partnered with international environmental activists to mount a vocal and visible opposition to the structural infrastructure projects. In 1991, Shapan Adnan, an activist sociologist supported by the Norwegian government's aid agency, published a highly critical account of early FAP efforts. Adnan and others raised criticisms that the FAP projects were both unwise and unjust. Raising questions about the practical wisdom of such projects, Adnan pointed to the "recurrent and systemic failure" of earlier structural flood control approaches in the region (Adnan and Ghani 1991).

Surveying the previous decades of embankment and poldering projects in the delta, Adnan saw a pattern of unjust distributional consequences, saying,

> the major beneficiaries of such faulty flood protection structures are obviously not the affected people at large, but the coterie of business interests and official functionaries involved in executing and maintaining such construction. (Adnan and Ghani 1991)

While past structural projects delivered benefits to large landowners whose agriculture and aquaculture interests could be improved by greater control over hydrological regimes, they destroyed common pool resources such as wild fisheries and grazing lands on which poor people disproportionately relied. As another layer of the unjust character of the FAP's structural protections, Adnan called into question the legitimacy of the non-democratic Ershad government under which the FAP was initiated.

In Adnan's view, the FAP process used the depoliticizing invocation of crisis to ignore this problematic track record and "rush to construction" without adequate participation and consultation of those people who would be most impacted (Adnan and Ghani 1991). He pointed out that, though the FAP included extensive studies, new procedures for participation, and the development of new institutional standards for environmental and social review, many of the structural projects were slated to precede these knowledge building and institutional programs, thus precluding any possibility that these efforts would substantially alter the structural approach.

In 1993, the European Parliament's Green Group convened a conference in Strasbourg to raise the profile of these FAP critiques among policy makers and the general public in donor countries. The conference included critical social science and humanities researchers like Adnan and subaltern studies scholar Gayatri Spivak, as well as Bangladesh-based NGO peasant activists, and international NGO representatives. The conference also included representatives of the World Bank and several FAP donor countries. The critiques raised and discussed during the conference again focused on both pragmatic concerns about the wisdom of flood infrastructure and political critiques of unjust neo-colonial regimes of knowledge creation, development, and dependency. The most damning critiques raised at the conference centered on the unjust impacts of the FAP, including that it would reinforce patterns of corruption and patronage, deepen already uneven risk and resource distributions, and continue privileging outside "professional advice and expertise" that were inappropriate to the context (Coordinating Committee 1994).

Many FAP critics regarded the investments in structural flood protections for Dhaka with great suspicion. Adnan explicitly criticized the BWDB's bias towards "technocratic solutions alone" and regarded the program of embankments and pumps for Dhaka as another example of a pattern in which the government institutes "capital intensive solutions" reliant on foreign aid without the institutional capacity to operate them properly. Citing problems with the design, implementation, and maintenance of Dhaka's embankments, he warned of the risk of catastrophic failure and described the embankments as having created "death traps" and "water traps" (Adnan and Ghani 1991). Adnan blamed the hastily built 'crash programme' embankments and floodwalls for causing internal waterlogging that created "large pools of foul-smelling and polluted water." Echoing the larger critique of the FAP programs as unjust, Adnan argued that Dhaka's new embankments were built to protect "landed property, residences, business and other buildings of the richer sections of the population of Dhaka city," while leaving many low income communities, such as Kamrangichar outside of protection (Adnan and Ghani 1991). Adnan also listed several forms of "corruption and resource misappropriation" that accompanied the Dhaka flood protection embankment project and other similar FAP projects. In the rush to build "physical works" like those constructed for Dhaka, Adnan, saw the work of "massive vested interests in the form of national and multinational construction firms lobbying for the contract." Where the "Ambassadors with Bulldozers" of the 1950s had largely been seen as benevolently wielding the transformative power of infrastructural modernization, in the 1990s, those same forces were viewed as pushing inappropriate and damaging projects that were more aimed at extracting profit than benefiting the people.

In the face of all of these criticisms, Adnan called for an immediate moratorium on the construction of physical flood control structures in Dhaka until "an integrated solution to the city's drainage and sewerage problems along with flood protection can be found" (Adnan and Ghani 1991). Adnan, like other critics of dry city infrastructural modernization, called for a return to the traditional building and settlement patterns and practices of the delta region. He argues that, "Much could be done by observing and building upon the indigenous practices of the floodplain peasantry, well-versed in coping with flood conditions" (Adnan and Ghani 1991).

By the time of the FAP programs in the 1990s, residents of the eastern Bengal delta had already seen decades of infrastructural modernization via flood protection and drainage infrastructure. Projects conceived by international consultants, funded by foreign aid agencies and development banks, and built and operated by the BWDB and its predecessor had widely failed to deliver on their promise of economic and social transformation. In many cases, the embankments, pumps, and canals brought on devastating social and ecological damage and invited sabotage and resistance from affected

populations[3]. The problems with Dhaka's embankments reinforced a widespread distrust of infrastructural modernization. This skepticism has continued in the years since with many critics resisting calls for further structural flood protections in Dhaka. Those who see embankment projects as symbols of corruption, foreign dependency, and the destruction of ecosystems and livelihoods advocate for "let[ting] the delta be a delta," preferring a restoration of an "open" approach to flood mitigation and drainage, as opposed to the "cordon" approach of polders and pumps (Islam 2016a). Nonetheless, in the years since the FAP studies, Dhaka's land use plans have continued to call for growth of the city's embankments.

DMDP: Revising Dhaka's Planning Vision to Incorporate Infrastructural Modernization

As discussed above, Dhaka's pre-FAP land use plans called for mitigating flood risks through land use regulation rather than embankments. Following the late 1980s floods, these plans were broadly disregarded with the construction of the city's embankments under the "crash programme" and the FAP 8a and 8b plans. Subsequent planning efforts have embraced the embankment-led urban growth model.

The Dhaka Metropolitan Development Plan (DMDP) was the first comprehensive spatial plan for the city after the 1981 DMAIUDP and FAP embankments. While the Planning Commission of the Government of Bangladesh led the DMAIUDP, the DMDP was headed by the successor to the Dacca Improvement Trust, the Rajdani Unnayan Kartripakkha (which translates as the Capital Development Authority) or RAJUK. The DMDP was funded by the UNDP/Habitat and supported by technical assistance from a large team of international and domestic consultants headed by UK-based Mott MacDonald. The DMDP was intended to guide investment, land use, and growth in the urban region from 1995 through 2015 through three linked plans, each more detailed than the previous: a "structure plan," "urban area plan," (UAP) and a series of "detail area plans" (DAPs).

The DMDP commenced in 1992 while the "crash programme" construction of the western embankments was still underway. Given the recent flooding events and the continued rapid growth of Dhaka's population, the DMDP placed major emphasis on the role of drainage and flood protection in securing adequate "flood free" land for urban development. In outlining the primary "issues" to be confronted, the Structure Plan states that "Dhaka's dominant feature is the small proportion of land which is permanently flood free" (RAJUK 1995). As such, "drainage (including flood control)" is one of the four "main components" of the plan. The DMDP largely mirrored the proposals put forth in the FAP 8a master plan, calling for full embankment of both western and eastern Dhaka, marking a dramatic departure from the proposals put forward in the city's previous plan, the DMAIUDP. Like the FAP8a plan, the DMDP argued that embankment-enabled land reclamation would improve urban environmental conditions and enable more equitable urban growth.

The DMDP Structure Plan, like previous plans called for the strategic use of land use controls both inside and outside of planned embankments. An integrated DAP land use map (Figure 3.19) issued by RAJUK in 2010 shows major areas both inside and outside of the embankments as off limits to urban development. Inside the embankments zones were designated in dark blue as "Water Retention Areas," necessary for retaining stormwater temporarily to reduce the demands on pumps. Outside the embankments, low-lying areas are shown in a white and blue hatch as "flood flow zones" in which no development would be allowed.

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[3] The late 20th century history of problematic water infrastructure interventions in rural Bangladesh is a well-told story in critical development studies. *Beel Dakatia: the environmental consequences of a development disaster* (1995), provides one especially stark example.

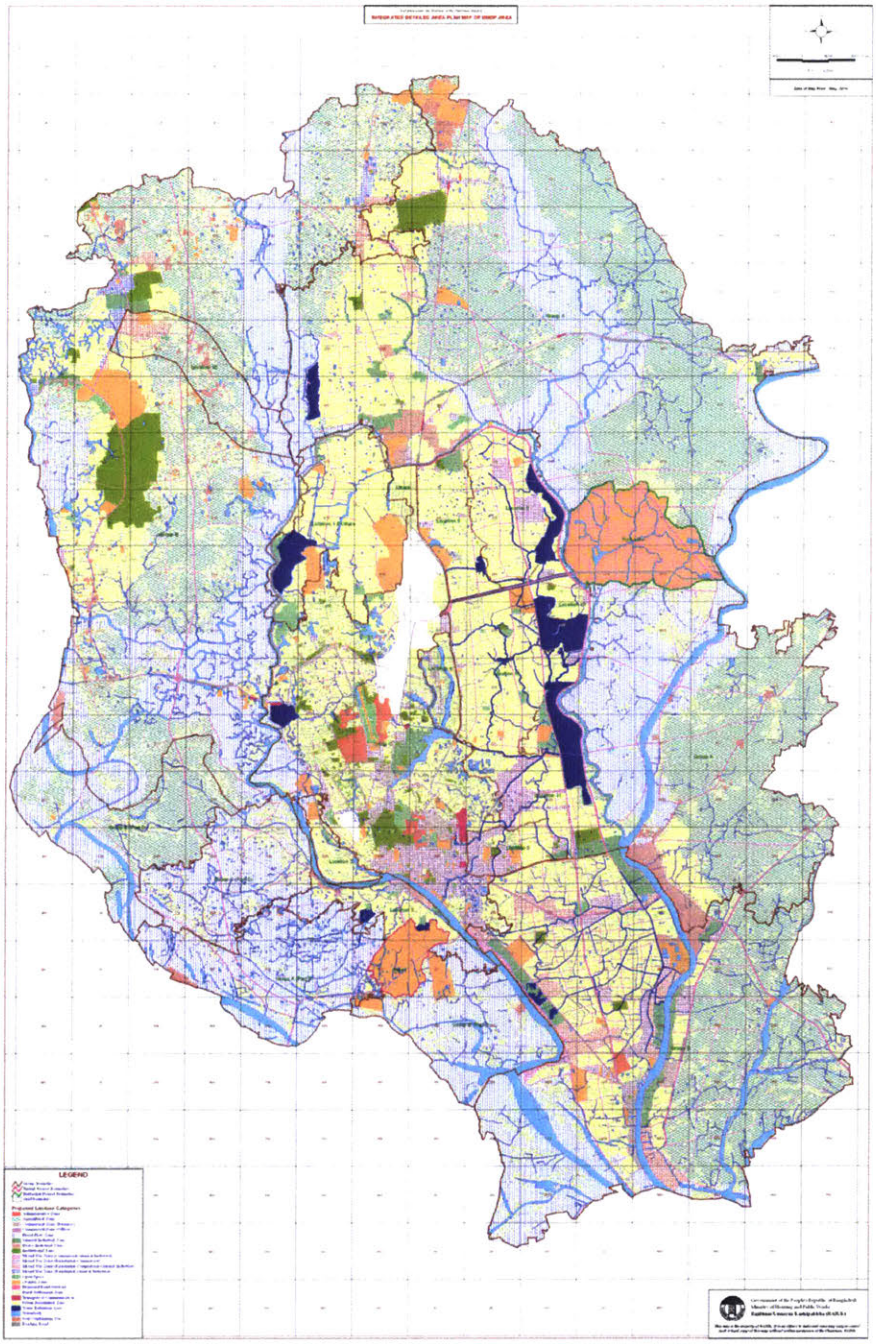

Figure 3.19. Detailed Area Plan map with retention areas (dark blue) and flood flow zones (light blue).

The DMDP's categorization of development restrictions for flood hazard mitigation matches the language used in the FAP 8a master plan. Like the FAP studies and previous Dhaka embankment studies before them, the DMDP linked flood protection infrastructure and land use regulation saying,

> in order to optimize the full potential of existing and potential new development land areas, the areas designated as retention ponds in natural depressions in the city's existing natural drainage system and khals must be protected at all costs (RAJUK 1995).

In addition to ensuring adequate stormwater retention, the DMDP recommended that land use controls limit development in low-lying areas to minimize levee effects and the potential for catastrophic losses in the event of a levee breach. Speaking about the then newly embanked areas of Dhaka city, the Structure Plan states,

> These potential new urban areas are however over 3.0 meters under water should the embankments fail (breach) or when they are overtopped (x year flood) [sic]. If such an eventuality occurs after these areas have become urbanized as they will be, given the high population pressure, then these new urban areas would be prone for potentially severe disaster (RAJUK 1995).

Along with land use controls, the Structure Plan recommended early warning systems and landfilling within embanked areas. Confronting the issue of catastrophic failure and residual risk in embankments, a supplemental study of Dhaka's drainage conducted for the DMDP goes further to recommend that, "for reasons of security and project longevity, landfilling should be preferred to empoldering where there exists an economic choice" (Mott MacDonald Ltd. 1993).

Thus, while the DMDP departed from previous Dhaka master plans by embracing flood control embankments, it did so in a qualified and limited way. The DMDP drafters explicitly recognized the dangers of embankments. They recognized that the functioning of the embankments and the mitigation of their risks would be dependent on the successful implementation of various non-infrastructural measures including land use controls and land filling. As the next chapter will discuss, the development of the city's structural flood protections has proven to be a simpler and more readily achievable project than enacting the recommended governance reforms and spatial restrictions.

Conclusions

In Dhaka, as in New Orleans, the dynamism of the river delta landscape has been an essential element shaping the city's growth. The strategic location of the city, on relative high ground above a relatively stable river near the junction of the great rivers of the delta, provided enormous advantages for commerce and military strategy for the colonial administrators who ruled the delta for the first three and a half centuries of the city's history. Though Dhaka saw booms and busts in population over this period, city leaders largely opted not to build flood control structures to protect the settlements from the seasonal inundation. Even after the "Ambassadors with Bulldozers" of the post-World War II years brought promises of transformative infrastructural modernization to post-colonial East Pakistan, city and national leaders continued to eschew major structural flood protections in Dhaka, instead relying on the newly established city planning institutions to direct urban settlements towards relatively flood safe areas. From Dhaka's Mughal period as the "Venice of the East," to Patrick Geddes' water-centered survey and plan for the city in the 1910s, to the DIT's mid-century planning and development projects, to the DMIAUDP's proposals for non-structural, land use-based flood mitigation in the 1980s, Dhaka embraced strategies of water management centered on the unbuilt aspects of the urban environment.

Around the same time that Bangladesh won its independence in the early 1970s, international engineering consultants began recommending a system of dry city infrastructures: earthen embankments, sluice gates, and pumps to protect Dhaka. Even with massive population growth following the end of the colonial era and the Liberation War, it was not until the early 1990s that such a system would be built. After two years of severe flooding in the capital in the late 1980s, the Ershad military regime instituted a 'crash programme' to construct emergency levees around the more urbanized western portion of the city. The late 1980s floods were also the motivation for the massive international mobilization of the Flood Action Plan, a World Bank-coordinated program of studies and infrastructure projects. The FAP represented a resurgence of infrastructural modernization fuelled by

international donors and consultants. The FAP included projects to formalize Dhaka's 'crash programme' embankments and a plan for more ambitious levees and pumps for the broader area. As in previous infrastructural modernization schemes in the region (e.g., the IECO Master Plan), Dhaka's FAP plans largely focused on investments in physical infrastructure, while recognizing that, to deliver on their transformative promise, these dry city infrastructures would need to be accompanied by non-structural, non-built interventions. These schemes allocated funds for pumps and levees, recognizing that, to function, these interventions would require radical changes in governance, administration, culture, and land use. Again and again these projects succeeded in realizing their visible and capital-intensive built components, while largely neglecting the slower and more socially complex non-structural components.

While the government broadly embraced the FAP's vision of infrastructural modernization, the proposals for embanking Dhaka, like other FAP projects, encountered significant resistance. Much as the legal challenges to the levee-led growth agenda in New Orleans East after Hurricane Betsy demonstrated a growing resistance to this aggressive form of infrastructural modernization, resistance to the FAP signaled a shift in Bangladesh. Increasingly, critics pointed to the track record of disappointing and damaging projects, arguing that dry city infrastructural modernization schemes were unwise and unjust. The rise and discrediting of Promethean projects of dry city infrastructural modernization in Dhaka set the stage for contemporary debates about how the city should adjust to the mounting challenges of rapid urbanization and climate change-linked flood vulnerability.

Taken together, the long history of dry city infrastructural modernization in Dhaka and New Orleans present some important lessons that might inform contemporary efforts to address mounting climate-change linked flood vulnerability.

The Uneven, Contested, and Crisis-Driven Progress of Infrastructural Modernization

The rise and discrediting of Promethean infrastructural modernization in both Dhaka and New Orleans over the 20th century was complex and uneven. The adoption of infrastructural modernization was not a linear, unidirectional, smooth process. The embrace of embankments and pumps as the primary tools of water management in Dhaka came only after decades of contestation and rejection of these methods in favor of non-structural methods, which frequently echo the favored tools of contemporary "resilient" landscape-centered planning. Even once dry city infrastructures were adopted in waves of crisis-driven urgency and depoliticization, boosters recognized that their success in delivering on transformative promises, was very much reliant on non-structural strategies.

The Promise of Control

As in New Orleans, the boosters behind Dhaka's infrastructural modernization promised that their projects would deliver transformative change in the spatial, social, and economic life of the city. In both cities, these projects were linked to evolving promises of growth and modernization. However, where New Orleans' levee boosters promised a form of modernization centered on *promoting* growth and competitiveness, the planners, engineers, and consultants behind Dhaka's embankments presented these infrastructures as a means of *controlling* rapid urbanization, bringing order and control to a place long regarded by technocrats and outsiders as chaotic and unsanitary.

Leveeing Out, Leveeing In: Equity concerns

The promoters of water infrastructural modernization in Dhaka, and in Bangladesh more broadly, frequently argued that their projects would benefit the poor as engines of economic empowerment. The encompassing form of the levees does indeed provide nominally 'comprehensive' protection to all inside those zones. However, the track record of these projects shows that, at least as frequently,

infrastructural modernization has produced patterns of uneven vulnerability that exacerbate existing inequalities. As will be discussed further in the next chapter, Dhaka's embankments pointedly avoided protecting Kamrangichar, one of the cities largest concentrations of low-income informal settlements. The embankments' disruptions of existing waterways and drainage pathways upset existing livelihoods and water flows in ways that disproportionately harmed the city's poor. Whether *leveed out* through exclusionary infrastructural alignments or *leveed in* to waterlogged low-lying areas, Dhaka's poor have frequently born a disproportionately heavy burden for dry city infrastructural modernization.

Climate change adaptation and urban change are creating mandates for renewed state-led infrastructural modernization in Dhaka, as in New Orleans and other cities around the world. As subsequent chapters will show, advocates of contemporary flood and drainage mega-projects are again offering promises of hazard reduction, renewed competitiveness, modernization, and order. These new projects also make implicit and explicit promises to repair the damages done by the historical transgressions of infrastructural modernization. To ensure that climate change adaptation does not become a pretext for a superficially rebranded infrastructural modernization, with all of the unwise and unjust consequences of the previous Promethean projects, it is essential to develop a clearer understanding of the emergence and evolution of previous generations of projects. The past two chapters have provided accounts of how Dhaka and New Orleans, two cities with similar flood vulnerabilities but radically different urbanization patterns, both came to build similar 20th century systems of levees and pumps through uneven and contested processes of infrastructural modernization. The next chapter will examine how these infrastructures, once in place, have been urbanized, creating distinctly different patterns of uneven development and uneven vulnerability..

PART II
The Urbanization of Flood Mitigation Infrastructure

Over the 20th century, New Orleans and Dhaka developed similar modes of dry city infrastructural modernization, relying on encompassing earthen embankments for flood protection and mechanical pumps for drainage. In both cities, these infrastructures were paired with administrative and regulatory strategies meant to work in concert with the levees to shape urban settlements. While they developed similar infrastructure and planning strategies, these efforts shaped urbanization in radically different ways in each city. Part II includes a single chapter that recounts the ways in which flood infrastructures have become embedded within broader socio-technical ensembles or levee complexes in each city, creating distinct patterns of infrastructural urbanization and uneven vulnerability.

This chapter uses analysis of infrastructure and land use planning documents, contemporary media accounts, and primary site observation and interviews in Dhaka and New Orleans to document how the urbanization of the cities' flood infrastructures have departed from their universalizing planning assumptions. It finds that infrastructure planners assumed that flood control levees and pumps would create distinct boundaries between inside and outside, dry and wet, urban and wild in both Dhaka and New Orleans. In fact, levees in each city have shaped urbanization in radically different ways based on the position of these infrastructures in broader levee complexes, which include other engineered interventions (e.g., pipes, pumps, roads, and canals), formal mechanisms for spatial governance (e.g., planning and building regulations), and informal social expectations of the role and efficacy of the state. Where New Orleans' levees do generally define edges between distinctly different settlement patterns, Dhaka's embankments have come to serve as spines of urbanization, spurring rapid growth both inside and outside the intended zone of protection. In both cities, levee projects, which promised to promote or guide urban growth, have largely not performed as anticipated.

Through brief case studies of three different areas within each of the cities, the chapter explores how the complex and dynamic socio-technical ensembles in which levees are enmeshed in Dhaka and New Orleans have shaped distinct patterns of urbanization and uneven vulnerability both between and within the two cities. While simple models including the growth machine, the levee effect, and the facilitation / marginalization model of uneven vulnerability from political ecology provide useful starting points for understanding how levees create uneven costs and benefits, these case studies illustrate that such models miss the crucial importance of place-specific, historically-contingent, path-dependent processes. Through the case studies, the chapter illustrates the ways in which uncooperative and unruly natural and human processes subvert the model-based assumptions of planners.

CHAPTER 4
Levee Complexes: Divergent Urbanization and Uneven Vulnerability

Introduction: Levees in the Urban Landscape

Standing atop the levees that surround New Orleans, there is no doubt that the landscape is profoundly shaped by engineered interventions. In a flat landscape, the levees rise some thirty feet above the surrounding terrain. In many places, the crown of the levees is higher than the roofs of neighboring homes. Through most of their length, the U.S. Army Corps of Engineers and the local levee boards maintain a pristine right-of-way extending several yards from the toe where the levees' slopes meet the surrounding grade. To enable inspections and maintenance, the levee slopes are kept clear of vegetation and encroaching structures. In many parts of the city, the levees are a place apart. They are trails for joggers and bicyclists. They are open spaces for restless city dogs in need of a place to run. And they are symbolically important urban edges that host formal and informal rituals from Christmas bonfires to Mardi Gras gatherings. The levees run in defiantly crisp lines through some 350 miles of riverbanks, marshes, and lakeshores. The precise geometry of their concrete armored slopes, towering floodwalls, and crenellated surge barriers, embody, in spatial and material terms, a generations-deep commitment to the idea that the city is to be protected, that swamps, rivers, and lakes are to remain on one side of the ramparts so that the life of the dry city can proceed unperturbed on the other.

Since the city's founding three hundred years ago, its residents have rallied enormous resources to build up these defenses. As described in chapter two, the process of building the levees, floodwalls, pumps, and gates that now encircle nearly one million residents in metropolitan New Orleans has been episodic, uneven, crisis driven, and, increasingly, contested. Nonetheless, the levees, as they stand today, embody an unambiguous investment in infrastructural modernization. In 1970, a USACE brochure described the levees of the lower Mississippi River as "among the greatest engineering feats of the world" (Mississippi River Commission 1970). In the nearly half-century since that pronouncement, the levee system has grown in height, extents, and comprehensiveness. In the most recent episode of levee building following the levee failures during 2005's Hurricane Katrina, local, state, and federal government agencies spent some $20 billion to reinforce the city's protections. Even as the realities of climate change, sea level rise, land loss, and subsidence call into question the long-term viability of settlement in the lower Mississippi delta, New Orleans' edge-defining levee protections embody the defiance of the 20th century Promethean project of dry city infrastructural modernization.

Where New Orleans' levees mark a decisive *edge* between different spatial and hydrological regimes, Dhaka's levees have become *spines* of urbanization, serving to spread urban settlements both inside and outside of their intended zones of protection. Since they were first built in the early 1990s, Dhaka's encircling embankments have become thoroughly embedded in the city's urban fabric. On the first morning of my first field visit to Dhaka in the summer of 2014, I hailed a "CNG," a three-wheeled auto-rickshaw powered by compressed natural gas, intent on surveying the city's flood control embankments on the banks of the Buriganga River. To direct the driver, I tried every English and Bangla word for levee that I could muster: *levee, embankment, badh, bund, dike*. When none of those options elicited any sign of recognition, I simply asked to go to the *nodi*, the river, and off we went. Initially, I attributed my inability to communicate with the driver to my limited Bangla language skills. However, as I worked with native Bangla speaking translators and research assistants over the coming years, I found that when they asked drivers, cycle rickshaw pullers, or neighborhood residents where to find the embankments, more often than not, they too were greeted with confusion.

Arriving at the riverbank that first morning in Dhaka, it became clear why the driver had not been receptive to my request to go to the embankment. I was armed with maps of Dhaka's embankments, which like my maps of New Orleans' levees, showed the infrastructure as bold lines outlining the periphery of the city. In preparation for my fieldwork, I had read various embankment planning documents and studied their drawings. Based on those plans and drawings, I knew that Dhaka's embankments were built to rise seven to ten meters above the grade of the surrounding city, roughly the same height as New Orleans' levees. But, as the CNG driver maneuvered to the side of a busy road not far from the bustling Buriganga riverfront, I could see virtually no evidence of the embankments, no pristine linear infrastructural right-of-way, no monumental grassy slopes rising above the city.

Dodging through the flow of trucks, buses, and bicycles on the road on my way towards the river, I thought, surely there must be some misunderstanding. Had the driver taken me to the wrong river? Were there major gaps in the city's embankments that simply didn't show up on my maps? Only after crossing the road several times, consulting my paper maps, and cross-checking them against the Google Maps display on my phone did I realize that I was at the right place. I was, in fact, on top of Dhaka's embankments. The blacktop road itself was the crown of the embankment, flanked on either side by a continuous line of tire shops, tea stalls, and small open air buildings where craftspeople made and sold elaborate carved wooden headboards, straw brooms, and boats. For the keepers of these shops, the embankment offered a relatively flood-safe and elevated site for their facilities, but, more crucially, it offered access to a rare decent road and the many thousands of potential customers who used the corridor every day. Dhaka's roads are clotted with some of the worst traffic congestion of any city in the world (Rosen 2016). Many roads are rendered impassable on a regular basis by waterlogging when heavy monsoon rains fill the street ("Waterlogged Dhaka Streets" 2017). The embankment, and the road on its top, offer a reprieve from both of these problems. And so the city, with its growing population, has grown to, from, over, and on the embankment.

On that morning in 2014, my driver and I could not see the embankments, not because they were not built to the height prescribed in the engineering plans, but because the surrounding terrain had been so radically transformed as to render the infrastructure itself largely invisible. Dhaka's embankments are not a clear boundary separating inside from out, city from river, dry from wet. Rather, they are dynamically expanding spines of urbanization. Through most of its more than 20-mile length along the Turag and Buriganga Rivers, Dhaka's western embankment bears little resemblance to the crisp angular geometries of its engineering plans (Figure 4.1). For much of its length, Dhaka's embankment has been absorbed into the surrounding urban fabric.

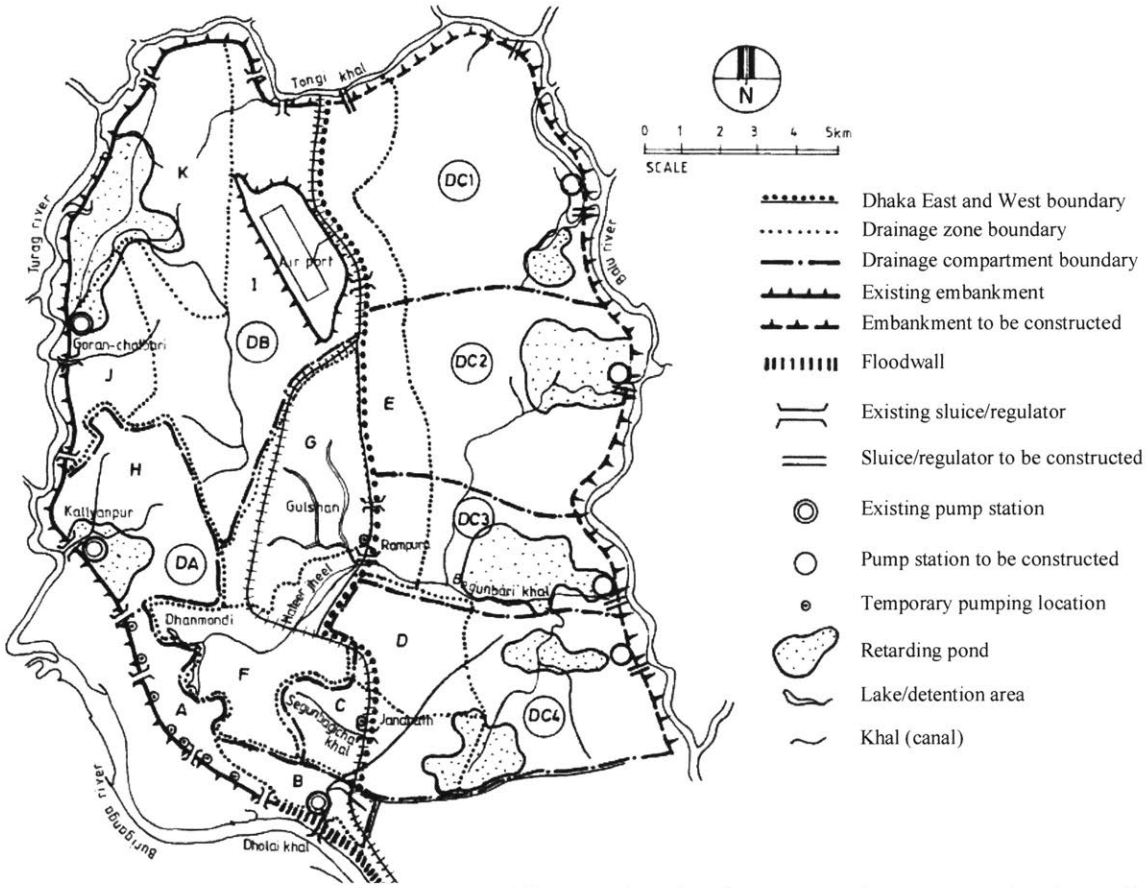

Figure 4.1. Dhaka's built (western) and planned (eastern) embankments as shown on a plan from the FAP 8b plan (1991).

Leveeing Dhaka and New Orleans

While the processes took distinctly different paths in Dhaka and New Orleans, by the end of the 20th century, both cities had embraced a vision of dry city infrastructural modernization, based on intensive investments in structural flood protections and mechanical drainage, linked to rational planning and engineering bureaucracies. Viewed through the universalizing lenses of 20th century civil engineering and city planning, Dhaka and New Orleans were substantially similar. Both were urban settlements in flood prone deltaic landscapes and both needed major investment in structural and mechanical infrastructure to create the dry conditions necessary for orderly and rational growth.

The rise of dry city infrastructural modernization in Dhaka and New Orleans shared some crucial features. First, in both cities, modernization through drainage and flood control was integrally linked to visions of urban growth. New Orleans' levee boosters saw these infrastructures as a means of encouraging growth, modernization, and competitiveness. In Dhaka, dry city infrastructural modernization was often presented as a strategy for controlling urbanization and growth, which in this context was viewed as chaotic and undisciplined.

The second crucial thematic linkage between infrastructural modernization in Dhaka and New Orleans is that, in both places, the process was not steady, linear, or unidirectional. As the previous chapters have shown, there have long been contestations regarding levee and pump-based modernization. As each city built its structural flood protections over the course of the 20th century, dissenting voices called for

alternative approaches. In both Dhaka and New Orleans, levee advocates increasingly recognized these critiques, but invoked the specter of catastrophic flooding to argue that there was no alternative for structural protection.

The third theme linking New Orleans' and Dhaka's 20th century dry city infrastructural modernization was that, in both cases, though the infrastructures were nominally "comprehensive" in scope, their benefits and costs were profoundly uneven in their distribution. In New Orleans, the uneven impacts of the city's levees were linked to racialized power imbalances and urban-rural distinctions, with the white urban power centers extracting maximum benefits from levee-based modernization. In both their initial design and in their emerging impacts, Dhaka's embankments were also marked by uneven impacts. The alignment of the western embankment bypassed large areas of poor informal settlements, such as those on Kamrangichar while the hydrological disruptions of the embankments disproportionately harmed the poor by causing waterlogging in low-lying areas and blocking existing waterways.

While the infrastructural and planning prescriptions put forward by engineers and planners in Dhaka and New Orleans were substantially similar, their impacts on urbanization has been radically different. This chapter traces the paths by which these shared visions for dry city infrastructural modernization have taken dramatically divergent paths in Dhaka and New Orleans. The chapter explores how Dhaka and New Orleans' levees have shaped and been shaped by the dynamic processes of urbanization in each city through a series of brief profiles of levee-impacted areas of each city.

The Politics of Flood Infrastructure

The golden era of infrastructural modernization was propelled by the promise of techno-scientific expertise, particularly from positivist-oriented disciplinary perspectives from engineering, economics, and rational planning. Since the late 20th century, scholars from a range of disciplinary perspectives have raised critiques, probing the underlying assumptions of the rationalizing discourses of infrastructural modernization and documenting and analyzing the myriad social, political, and ecological consequences of these projects. To contextualize this chapter's empirical analysis, this section briefly recounts some debates relevant to understanding the "thick" politics of levees and other infrastructures (Bijker 2007b).

As discussed in Chapter 1, much of the literature on how hazard vulnerability is produced aligns roughly with broader 'structure versus agency' debates. On one side, natural hazards researchers focus their inquiry on the role of individual and household risk perception, choice, and adaptation. This line of research views hazard vulnerability as largely dependent on *behavioral* factors. A core behavioral insight from the natural hazards school is the identification of the 'levee effect', the tendency for structural flood protections to lead to increased, rather than decreased, flood vulnerability by 'creating a false sense of security' which then leads to poorly adapted settlement and building patterns (White 1945; Laska 1990; Colten, Kates, and Laska 2008). If hazards research focuses on the role of individual *agency* in producing hazard vulnerability, vulnerability researchers (Hewitt 1983; Wisner et al. 2004) and early political ecology researchers (Blaikie and Brookfield 1987; Pelling 1999) put particular emphasis on locating the *structural* sources of uneven vulnerability in broader systems of socio-economic power. Timothy Collins's work on the production of uneven hazard risk via marginalization and facilitation is a clear example of the structural approach to the political ecology of vulnerability (Collins 2010, 2008).

More recent scholarship from urban political ecology (UPE) and other realms has broken down the stark structure/agency divide and brought increasing attention to urbanization as an ongoing "metabolic" process, which necessarily placed social and natural processes in relationship to one another through various forms of "hybridity", "cyborg urbanism", and "socio-natures" (Swyngedouw 1996; N. C. Heynen,

Kaika, and Swyngedouw 2006). Urban water systems, particularly fresh water delivery (Kaika 2004; Swyngedouw 1999; Gandy 2002) and sewer systems (Gandy 1999b), have been among the most frequent areas of study for UPE scholars. Many of these studies examine the role of water infrastructures in creating or reinforcing patterns of uneven development (N. Smith 1984) in colonial and post-colonial urban environments, including in South Asia (Ranganathan 2015; Gandy 2008; McFarlane 2008; Arabindoo 2016; Anand 2011). Much of this work on the political ecology of urban water infrastructure highlights the ways that, as Matthew Gandy says, "water is a brutal delineator of social power" (Gandy 2004). Several UPE aligned scholars have begun to consider the socio-spatial implications of urban drainage infrastructure in both the Global North (Cousins 2017a, 2017b) and South (Gandy 2006; Ranganathan 2015), but relatively little scholarship has taken up Vanessa Watson's call for North-South relational and comparative research (Watson 2009) in the realm of the political ecology of urban flood risk (Ranganathan and Balazs 2015; Goh 2015).

In accounting for the variety of urbanization forms and processes, recent UPE scholars have argued for complementing Marxian analysis with "assemblage" theories of socio-technical ensembles (Deleuze and Guattari 1987) and actor network theory (ANT), in which non-human "actants" are recognized as exercising agency in socio-natural processes (Latour 2005). Several critical scholars have used the language of assemblage in analyzing the development, functioning, and uneven impacts of water infrastructure (Ranganathan 2015; Carroll 2012; J. A. Lewis and Ernstson 2017). For some, floods themselves are "socio-natural-technical assemblage" (Walker et al. 2011). Though critics have charged that the integration of assemblage theory into studies of urban political ecology does not allow for a coherent political-economic critique and verges into "naïve objectivism" (Brenner, Madden, and Wachsmuth 2011), some have sought to merge assemblage and ANT modes of analysis with Marxian rooted political ecology (Ranganathan 2015). In highlighting shared concepts of 'fixity' and 'flow' in Marxian urban geography and the STS-rooted theorizations of dynamic assemblages, Ranganathan's account of Bangalore's drainage systems bridges these two lines of theoretical inquiry (Ranganathan 2015). In this formulation as in many other analyses of the politics of urban flood infrastructure, hydraulic flows are related to flows of capital and power (Ranganathan 2015; Molle, Mollinga, and Wester 2009; Anand 2011).

Much as Ranganathan insists on the importance of fixity as well as flow in her analysis (Ranganathan 2015), the cases in this chapter make clear that patterns of obduracy and path dependency are critical to understanding the role of flood infrastructure in shaping urbanization. Observers of capitalist urbanization processes have recognized the tendency for crisis-driven restructuring of the built environment of cities, driven both by over-investment (Harvey 1978) and by the invocation of natural disaster-related crises (Gotham and Greenberg 2014). While these processes of 'creative destruction' (Schumpeter 1942) are surely at work in some of the infrastructural modernization schemes that have shaped Dhaka and New Orleans, it is also critical to better understand how socio-spatial patterns become fixed or obdurate in between these cycles of restructuring. Scholars of historical institutionalism have developed the concept of "path dependence" to describe the phenomena whereby choices early in a process can constrain the options available later by increasing the "cost of switching" (Pierson 2000). Similarly, STS scholars have developed the concept of "obduracy" to describe the tendency for certain socio-technical arrangements to become relatively fixed in place due to the linkages between social and material elements in a network (Hommels 2005). As the cases in this chapter make clear, infrastructure investments that radically alter hydraulic conditions create patterns of profound path-dependency and obduracy, wherein the choice to change the configuration of land and water in a place can encourage settlement and investment patterns, which, in turn, reinforce the need for further dry city infrastructural modernization. The cases presented here will also make clear that, while dry city

infrastructures have typically been designed using universal logics of engineering and planning, the forms of obduracy and path-dependency created by these investments are not universal, but rather historically-contingent and place-specific. While both Dhaka and New Orleans' levees and pumps have created patterns of path dependence and obduracy, these patterns differ dramatically as a function of the composition of the levee complexes into which these infrastructures have become enmeshed.

Similar Infrastructures, Divergent Urbanization

The following sections make the case that dry city infrastructural modernization in Dhaka and New Orleans have shaped urbanization in a variety of complex and dynamic ways, frequently defying the expectations of planners and engineers. The designers and planners of dry city infrastructures in New Orleans and Dhaka shared broadly parallel visions of how their projects would shape urbanization in their respective cities. While these projects have indeed had profound impacts on their cities, those impacts have been radically different from one another and have frequently departed from the visions of planners. The divergent pathways of infrastructural urbanization in Dhaka and New Orleans have largely been driven not by differences in the underlying infrastructures or plans, but by how those infrastructures and plans have been incorporated into dynamic social-technical ensembles or levee complexes. Through these complexes, the impacts of the earthen embankments and floodwalls at the center of dry city infrastructural modernization are linked to other technical components (e.g., pumps, canals, roads), underlying natural processes (e.g., sedimentation, subsidence, and land loss), formal legal and regulatory structures (e.g., flood insurance, zoning codes, building regulations), and informal social processes (e.g., selective or nonexistent enforcement, social expectations of state action, emergent and embedded social knowledge). The following sections present brief cases from Dhaka and New Orleans to illustrate the complex and dynamic ways in which dry city infrastructures have been urbanized in Dhaka and New Orleans. In each city, the brief cases include one area within levee protections and two areas outside of levee protection, one more or less formal in its development and one more or less informal (Table 4.1).

City	Inside	Outside (Formal)	Outside (Informal)
New Orleans	Eastern New Orleans	Venetian Isles	The Batture
Dhaka	Western Embankment	Eastern Dhaka	Kamrangichar

Table 4.1. Mini-case study sites in Dhaka and New Orleans.

New Orleans' Levees: A Problematic and Porous Edge, but an Edge Nonetheless

As described in Chapter 2, New Orleans' existence as an urban settlement has been dependent on structural flood protections since the city's 18th century colonial settlement. Over the course of the 18th and 19th centuries, public and private actors grew the levees along the Mississippi River in height and extent, eventually forming continuous ramparts along thousands of miles of the river and its tributaries. Beginning in the late 19th century, new state and local institutions mobilized scientific study, modern engineering, and rational planning to enact a vision of dry city infrastructural modernization wherein a system of levees, pumps, pipes, and canals opened up vast areas of formerly inundated and flood-prone land for urban expansion. Following the flooding of large areas of the city in Hurricane Betsy in 1965, the USACE undertook the Lake Pontchartrain and Vicinity Hurricane Protection Project (LPVHPP), which expanded and reinforced levee protections and placed the flood protection of the city squarely within the purview of the federal government. A 1970 USACE brochure explaining the LPVHPP proclaims that "the metropolitan area must be protected" and illustrates the project with battle-plan like maps of completed and proposed levees and other structures and a series of aerial perspective drawings showing massive new closure structures (Figure 4.2).

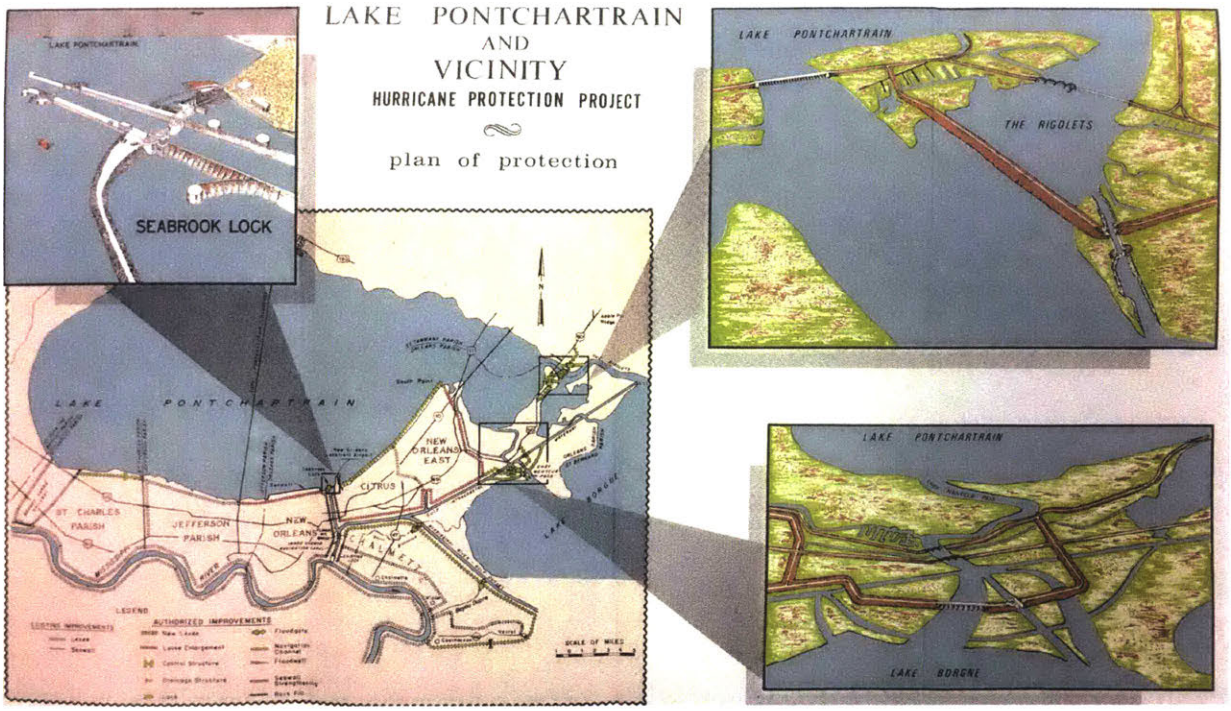

Figure 4.2. Lake Pontchartrain and Vicinity Hurricane Protection Project brochure with plans and aerial renderings of closure structures (1970).

After Hurricane Katrina again flooded the city through numerous levee and pump failures in 2005, the USACE reinforced what had been a porous and incomplete "system in name only" (Schwartz 2006). After roughly $20 billion in investment from federal, state, and local governments, the system protects over 360 square miles of urban and suburban territory. Though New Orleans' levees have been radically reinforced, in naming this post-Katrina flood protection works, the USACE adopted a less assured tone, shifting from the language of "protection" used in the LPVHPP to the language of probabilistic risk reduction for the new "Hurricane and Storm Risk Reduction System." Nonetheless, the massive levees, gates, and surge barriers have doubled-down on the vision of treating the New Orleans metropolitan area as what the *New York Times* calls a "fortress city" (Schwartz 2018).

As suggested by the language of "barriers," "gates," "fortification," "armoring," and "protection" that is commonly used to describe New Orleans' flood protection systems, this infrastructure has been conceived to separate inside from outside, dry city from wet hinterlands. Throughout most of the length of the city's perimeter fortifications, settlement patterns inside are distinctly different than those outside. The following brief accounts of three distinct settlement conditions shaped by New Orleans' structural flood protections make clear that, while the levees tend to form a stark edge to settlement and hydraulic regimes, the character of that edge varies considerably over time and from place to place. The accounts of levee-impacted settlements illustrate that flood protection structures alone have not created these stark edges. Rather, the delineation created by the levees, floodwalls, and gates is frequently altered, reinforced, and elaborated by other ecological, technical, and social factors. The following sections consider how levees have shaped urbanization in New Orleans in three distinct settings: the leveed suburban expansion of eastern New Orleans; the growing suburban territories

outside of the levees; and the Batture, an informally developed enclave outside of the Mississippi River levees (Figure 4.3).

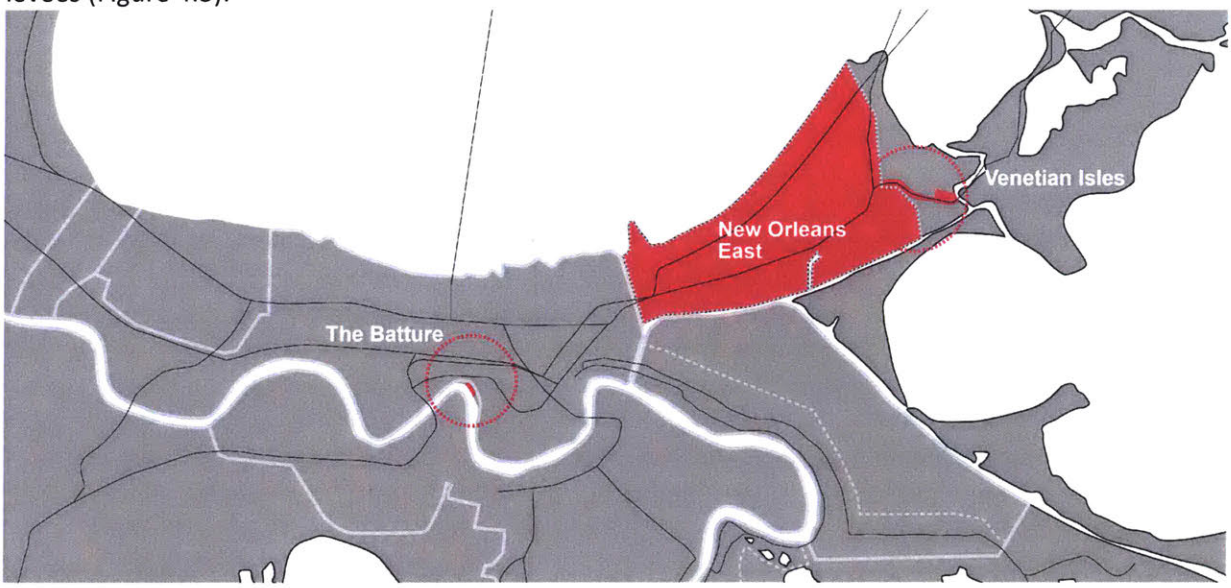

Figure 4.3. New Orleans research sites.

New Orleans East: planned growth and unplanned vulnerability

As discussed in Chapter 2, during the latter half of the 20th century, the eastern portion of the City of New Orleans was seen as the last best hope for urban expansion to enable the city to compete with surrounding suburban parishes and with other sprawling Sun Belt cities. Just a few corporate owners controlled tens of thousands of acres of low-lying and largely undeveloped land in the area. This consolidated ownership created a rare opportunity for large-scale planned development within short commuting distance of the center city. As suburbanization gained momentum in the New Orleans metro area and around the country in the 1950s, city planning officials saw eastern New Orleans as the only remaining area within the city limits available for suburban expansion. Private real estate firms tied to investors from Houston and New York developed a series of plans for the area.

Early 20th century attempts to develop the vast acreage of eastern New Orleans as gentleman farmsteads and citrus groves largely floundered as the area suffered periodic flooding in coastal storms. For eastern New Orleans to fulfill its promise for suburban expansion it would require extensive investments in flood protection and drainage. Extolling the alchemical power of modern drainage engineering, a corporate history produced for the area's largest landowners, New Orleans East Inc., celebrated the city's victory over its swampy environment saying, "New Orleans literally rose like Venus from the sea" and "now it is the turn of *New Orleans EAST* to assume its role in the area's march of progress" (Samuel 1959). After a 1947 hurricane flooded the area, the local levee board drew up plans for the protection of eastern New Orleans following the model of coupled real estate development and flood protection project undertaken on the city's western lakefront during the 1920s to 1940s (Perez and Thompson 1950). While the levee board's plan was never realized, the USACE was also developing plans for expanding federal levee protections. In 1962, the USACE submitted preliminary plans for the Lake Pontchartrain and Vicinity Hurricane Protection Project (LPVHPP), including new lakefront flood protections for eastern New Orleans. While the plans had been in the works for several years, it was not until Hurricane Betsy flooded major portions of the metropolitan region in 1965, that congressional appropriations were made to fund the new levees and other protections. The LPVHPP levees, along with other federal investments and the accompanying drainage infrastructure build by the local Sewerage

and Water Board (SWB), were essential to the suburban expansion of eastern New Orleans over the second half of the 20th century. However, the most ambitious of the planned expansions were only partially realized due to the confluence of mounting environmental regulations and the faltering of the oil economy in the region.

Levee-Enabled Growth

Public investment in dry city infrastructure played a central role in the development of eastern New Orleans. As had been the case in previous rounds of levee-enabled growth along New Orleans' western lakefront, public funding, engineering, and planning were mobilized to open new territories for suburban expansion and modernization. These processes of levee-led growth are a clear instance of public and private growth coalitions or 'growth machines' (Logan and Molotch 1987). In the case of eastern New Orleans the mutual dependence of private real estate developers and hydraulic bureaucracies was readily apparent. New Orleans East Inc., and other developers lobbied aggressively for investments in drainage infrastructure for the area (Baxter 2014) and discussions of public investment in water infrastructure were prominently featured in marketing materials for their developments. By one estimate, the public flood protection investments enabled by the 1965 Flood Control Act increased land values in the area from around $200 per acre to $15,000 per acre (Sothern 2007). While private real estate development efforts in eastern New Orleans were utterly reliant on public infrastructure investments, the federal and local hydrocracies were similarly reliant on the promise of real estate development in advocating for their projects. When the USACE proposed new eastern New Orleans levees after Hurricane Betsy, only 21% of the economic benefit used to justify the project came from protecting existing assets while 79% was based on the value of projected new development that would be enabled once the area was leveed (Burby 2006).

While this interdependent relationship between public investment in water infrastructure and private real estate development aligns with the 'growth machine' model, this model misses many of the critical processes that have shaped the patterns of development and flood vulnerability in the area. As described in Chapter 2, the earlier lakefront reclamation project was the product of a unified civic and commercial elite firmly in control of the new local city planning and hydraulic bureaucracies. By the mid-20th century when public and private actors had their sights set on developing eastern New Orleans, this unified front had largely broken down. In eastern New Orleans, the major private developers were not local power players, but investors from the Houston oil boom and from the world of New York finance capital (Baxter 2014). Similarly, many of the key functions of public power and funding had also shifted away from local institutions like the SWB, the Orleans Levee Board (OLB), and the City Planning and Zoning Commission (CPZC) to federal actors. Along with the USACE's levee protections, the federal government committed major investments to highway construction and a new NASA manufacturing facility in the area to spur development. Even as the federal government was driving investments in eastern New Orleans, it was also the federal government, in the form of new environmental regulations enforced by federal courts, that placed significant limits on the development by halting the USACE's most ambitious structural flood barrier plans, the storm surge closure structures that would have hydrologically separated Lake Pontchartrain from the Gulf of Mexico. Thus, the conventional understanding of growth machines as composed of stable and unified local coalitions crucially misses the ways in which the many of the critical actors in this case were neither local nor allied in a single-minded vision.

Levees, Risk Perception, and Uneven Vulnerability

In many ways, eastern New Orleans in particular, and the city as a whole, are textbook examples of the levee effect at work. Increasing investments in flood infrastructure over the course of the 20th century

enabled the spread of urban and suburban development into ever more low-lying lands. In 1900 90% of the city's population lived above sea level. With increasing investments in levees, pumps, and pipes, that percentage dropped to 48% by 1960 and 38% by 2000 (Campanella 2008). This move to lower lands was paired with changes in the form of settlements and building typologies. Much of the new development was more suburban in density and less adapted to flooding in building form. The dominant building typologies in eastern New Orleans and other new suburban developments increasingly rejected the features of traditional New Orleans architecture that had developed to cope with the flood hazards of the region. Historical geographer Richard Campanella describes the linkage between changes in flood infrastructure and changes in dominant architectural typologies this way,

> So secure were New Orleanians in their technological salvation from floods that the centuries-old tradition of building housed raised on piers was abandoned, after World War II, for faster, cheaper slab-at-grade foundations. (Campanella 2008)

Over the latter half of the 20th century, this combination of settlement expansion into low-lying territory, suburbanization, and the abandonment of traditional architectural adaptations took place across the New Orleans metropolitan area. The pattern was especially apparent in eastern New Orleans. The post-Hurricane Betsy federal levees, paired with massive bond-financed local investments in drainage infrastructure enabled the large real estate corporations to move forward with ambitious suburban development plans. A 1975 survey of homeowners in New Orleans East found that over 90% of homes were built on concrete slabs rather than the pier-elevated construction common in New Orleans (Earle Jr 1975).

When Hurricane Katrina struck the area in 2005, breaching the levees surrounding eastern New Orleans in several places, the area, with its unelevated construction, was utterly devastated. This would appear to be a clear instance of the 'levee effect' at work. Levees and pumps enabled development patterns that were not well-adapted to flooding dynamics of the region, leading to catastrophic losses when those engineered protections failed. In the words of some of the founders of natural hazards research, even as technical knowledge of hydrology, climate, and flood risk has improved, eastern New Orleans is an example of "knowing better and losing even more" (White, Kates, and Burton 2001).

While the development of eastern New Orleans did reflect a levee effect in many respects, an analysis of the area's flood vulnerability that focused only on the impacts of choices and risk perceptions of homeowners and residents would miss the crucial actions taken by powerful public and private actors that shaped the vulnerability of eastern New Orleans. Developers skimped on fill and marketed slab-on-grade houses as the modern alternative to old-fashioned raised New Orleans houses (Baxter 2014). A broad array of public agencies mobilized to enable the risky development of the area, including boosters like the utility and transit provider New Orleans Public Services Inc., who urged New Orleanians to "join the parade to better living" (Figure 4.4) (Souther 2008). Since the establishment of the National Flood Insurance Program (NFIP) in the wake of Hurricane Betsy, the federal government has effectively subsidized development in flood prone regions like eastern New Orleans by providing insurance at below actuarial rates. While the program was designed to include many floodplain management and risk mitigation components, it has proven extremely vulnerable to political pressure from pro-growth interests. Politicians and developers frequently seek to shape risk mapping and policy determinations to reduce insurance requirements and costs to enable development in risky landscapes. Of particular relevance for levee-protected places like eastern New Orleans, pro-growth interests have frequently lobbied the federal government to systematically underestimate the "residual risk" of flooding to property protected by levees (King 2015; Adelson 2016). Thus, any consideration of a levee effect as a

driver of ill-adapted settlement and building patterns must focus not only on the impact of levees themselves, but also on a suite of levee-aligned factors shaped by public and private interests.

Figure 4.4. New Orleans Public Service Inc. advertisement promoting suburban development in eastern New Orleans.

Uncooperative Natures and People

While structural models like the growth machine and behavioral models like the levee effect provide useful starting points for understanding particular dynamics of how levees shape uneven vulnerability in places like eastern New Orleans, these two general models miss some very important drivers of uneven vulnerability rooted in the specific biophysical and social dynamics of the region. As in the metropolitan region at large, "uncooperative natures" (K. J. Bakker 2003) are important drivers of vulnerability in eastern New Orleans. The flood vulnerability created by naturally low-lying topography and the prevalence of ill-adapted building types was compounded by changes climate, hydrology, and soils due to processes operating at the global, regional, and local scale. Sea level rise, driven by global climate change is increasing water levels in the Gulf of Mexico. This global phenomenon is compounded by regional subsidence, or land sinking, across the lower Mississippi Delta due to a combination of pre-existing geological processes and the interruption of sediment flows by levee barriers along the river (Blum and Roberts 2009). The vulnerability brought on by these global and regional phenomena is compounded in eastern New Orleans by rapid local subsidence. The waterlogged and highly organic soils that underlie many of the later developed portions of the metropolitan area have a tendency to shrink and compact when they are drained and developed. Since the area was leveed and drained in the mid-

20th century, eastern New Orleans has seen some of the highest subsidence rates in the region. While subsidence across the city has averaged 5mm per year since the early 1950s, some areas of eastern New Orleans have seen subsidence rates of up to 12mm per year (Burkett, Zilkoski, and Hart 2001). Just five to ten years after the area was developed a survey of homeowners in eastern New Orleans found that 60% had added additional fill to their lots and 45% reported problems with subsidence (Baxter 2014). By the mid-2000s, much of eastern New Orleans had sunk to six to twelve feet below the water level of Lake Pontchartrain. Both at a local and regional scale, levees have been a critical part of shaping "uncooperative natures" in manipulating flows of water and sediment, producing uneven flood vulnerabilities.

Much as the conventional structural and behavioral models of levee driven urbanization and flood risk miss the crucial role of uncooperative natures in producing eastern New Orleans' flood risk, they also miss the role of local social dynamics and politics. Both municipal planning authorities and private developers promoted the development of eastern New Orleans as an opportunity to simultaneously grow the city and to address entrenched problems associated with the older sections of the city. Though the development plans always incorporated African-Americans (first in segregated neighborhoods (Perez and Thompson 1950) and later in integrated ones), eastern New Orleans was the city government's attempt to stem the tide of white New Orleanians fleeing integration and moving to outlying suburban parishes. In 1970, in the early years of suburban development in eastern New Orleans, the area was considerably more white than the city at-large, with only 15.1% of the population composed of African-Americans. However, following the oil bust and ensuing real estate crash of the 1980s, the population of eastern New Orleans shifted. Though the area's growth slowed, it became a "powerful magnet" for the city's middle-class African American population, among whom the outlying suburban parishes were widely viewed as hostile (Souther 2008). By 1990, the African American proportion of eastern New Orleans population had increased to 63.5% (Lauria 1998). In recent years, the population of the area has continued to become more heavily African-American. Though African-Americans made up just under 60% of the population of the city, in 2016, that proportion was 85% for eastern New Orleans (Greater New Orleans Data Center 2016). While the area did become home to an increasing proportion of the city's African-American middle class and affluent residents, it has also seen increasing rates of poverty. The city at-large has a poverty rate of 26.2%. Eastern New Orleans' poverty rate is 32%. Eastern New Orleans was envisioned as a prosperous and diverse suburban expansion to stem the tide of 'white flight' from the city. In the end, the area has come to house a greater proportion of African-American households and households in poverty than the city at-large. By virtue of both planned action and uncooperative natures, this area is also now exposed to heightened flood vulnerability placing this socially vulnerable population at even greater risk.

The area's low-lying topography, poorly adapted built environment, and subsidence made eastern New Orleans especially vulnerable to the catastrophic flooding following the levee failures of Hurricane Katrina. In the eyes of many residents, it was the area's high rates of minority and poor residents that made them vulnerable in the aftermath of the flooding. In the immediate aftermath of Katrina, a private company opened a large landfill to handle storm debris adjacent to an area of that is home to a large Vietnamese-American community. Only after protracted legal battles and community organizing was the facility closed (Eaton 2006). In the months after Katrina, there were many proposals put forward to "shrink the footprint" of the city, in nearly every case, proposing to abandon major sections of eastern New Orleans. According to geographer Richard Campanella, those advocating for strategic retreat in eastern New Orleans were largely "educated professionals who live on high ground" who "never found [eastern New Orleans] structurally appealing in the first place" (Campanella 2008). For those who lived

in the area and wanted to stay, footprint shrinking proposals were the work of "elitist, classist, racist landgrabbers" (Campanella 2008).

While the levee-enabled development of eastern New Orleans is, in many ways, a clear example of both a levee-enabled 'growth machine' and the 'levee effect,' both the structural and behavioral explanations are inadequate to explain the links between levee construction and the production of uneven vulnerability in the area. The 'growth machine' model misses the complexity, fragmentation, competition, and uneven nature of both state and non-state actors essential in the development of the area. Similarly, the emphasis on risk perception and individual choice that guides the 'levee effect' model can occlude the importance of structural drivers that shape choices as well as unruly natures and place-specific politics.

Suburbanization Outside the Levees

When New Orleans' city leaders pushed to expand dry city infrastructures over the course of the 20th century, the investments were often justified on the basis of enabling suburban growth and modernization within the city limits in order to compete with surrounding suburban parishes that were absorbing an ever-larger proportion of the region's population growth. In laying out their 1959 plans for development in eastern New Orleans, Harland Bartholomew estimated that the area would house some 400,000 people by 1980 (Harland Bartholomew and Associates 1959). In 2016, the entire city of New Orleans had less than 400,000 residents and all of the neighborhoods of eastern New Orleans housed less than 75,000. While New Orleans did not fulfill the growth ambitions of the city's mid-century levee boosters, the metropolitan region did continue to grow. Though new dry city infrastructure like the LPVHPP opened up extensive new territories to suburban development, growth in the region has increasingly shifted to areas that are not protected by levees, such as St. Tammany Parish and its 'Northshore' suburbs. The relationship between the late 20th century levee expansions and increasing growth in unleveed areas complicates the conventional structural and behavioral understandings of the links between flood infrastructure and growth. The following section outlines some of these trends and the ways in which unruly natural and social processes have run counter to dominant explanations.

Though 20th century dry city infrastructural modernization in New Orleans did open extensive new territories to suburban expansion, the connection between infrastructural investment and growth is not as clear as one might expect. Of the seven parishes (counties) that make up the U.S. Census' 2010 New Orleans-Metairie-Kenner Metropolitan Statistical Area (MSA), the post-Hurricane Betsy LPVHPP provided structural protections for portions of four parishes: Orleans, Jefferson, St. Bernard, and St. Charles. The post-Hurricane Katrina infrastructures largely followed the alignment set by the LPVHPP. These protections did not directly impact the other three parishes in the MSA: St. John the Baptist, Plaquemines, and St. Tammany (Figure 4.5).

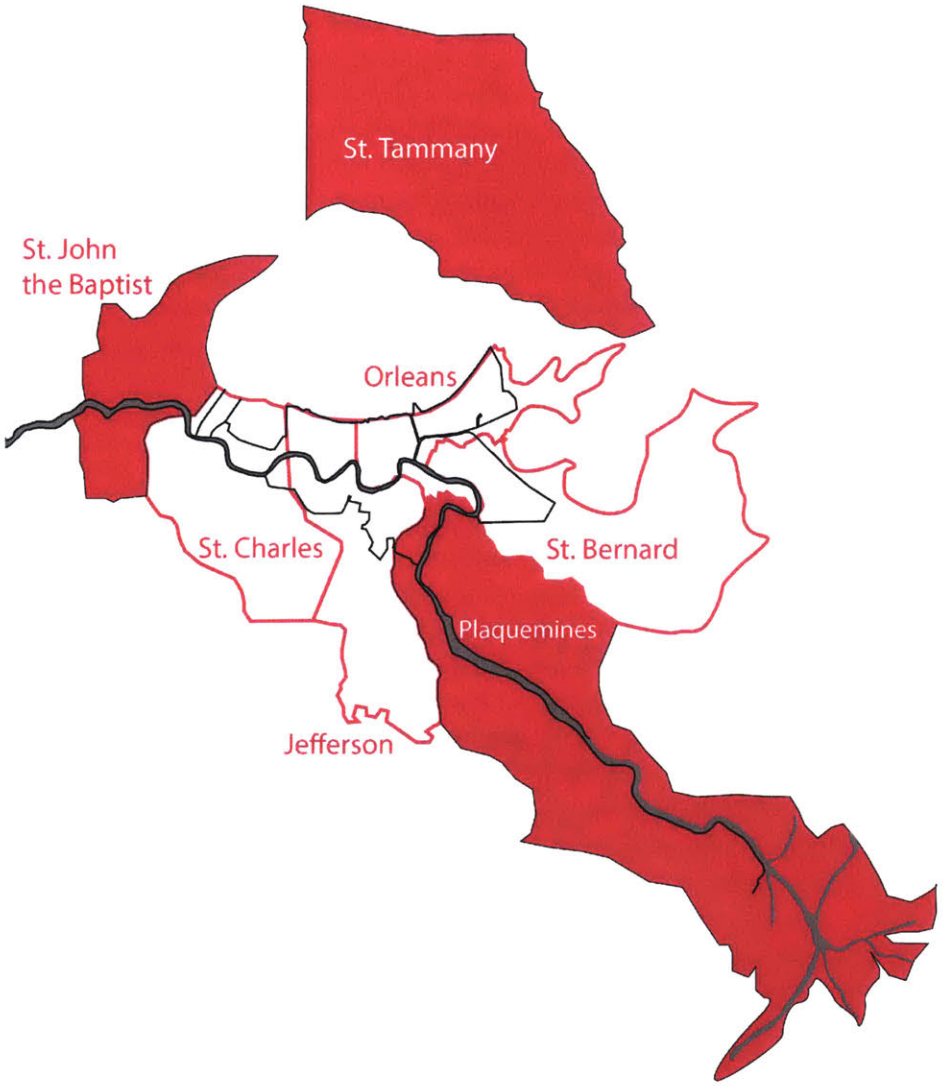

Figure 4.5. New Orleans MSA Parishes and post-Betsy and Katrina hurricane protection levees (in black). Outside parishes in solid pink.

The parishes that received protections from the LPVHPP projects constituted the core of the urban settlement and the suburban areas directly up and downriver from New Orleans. In the years before Betsy, these areas grew rapidly. In the sixty years between 1900 and 1960, the *inside parishes* (Orleans, Jefferson, St. Charles, St. Bernard) grew by 181%, gaining a total of 573,071 residents. Over that same period, the *outside parishes* (St. Tammany, Plaquemines, and St. John the Baptist) also grew, though at a considerably slower pace, gaining 106% or 165,700 residents. While levee boosters in New Orleans had long treated structural flood protections as an integral part of the public-private growth machine, in the years after the LPVHPP, growth in the unleveed parishes actually far outpaced that in the leveed parishes. From 1960 to 2000 the parishes that received post-Betsy levees grew by only 19% or 165,700 residents while the three *outside* parishes grew by 228% or 181,442 residents. In spite of the massive investment in flood protection infrastructure that came in the later decades of the 20th century, since 1960, New Orleans' population had fallen from a high of nearly 630,000 to under 500,000 by 2000 (Figure 4.6). Over the same period, the population density in the city dropped from 17,000 people per square mile to 7,300 per square mile (Campanella 2008). While the massive displacement and demographic flux that followed Hurricane Katrina led to significant fluctuations in area populations, the

area of the MSA with the highest growth rates since 2000 has been unleveed St. Tammany Parish at 33% growth between 2000 and 2016 (Figure 4.7). Thus, while investments in levees and other engineered flood infrastructures for New Orleans were long justified on the basis that they would enable urban expansion, it has actually been those parishes with less substantial levee protection that have grown fastest in the years since the major post-Hurricane Betsy and Katrina levee investments.

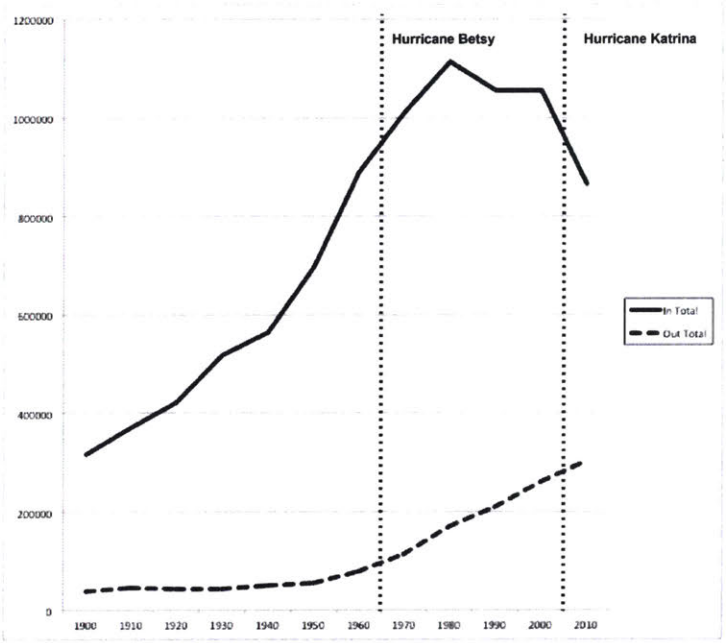

Figure 4.6. Since Hurricane Betsy and the LPVHPP, population has grown significantly in those parishes that did not receive protective infrastructure, while 'inside' parishes have been steady to declining.

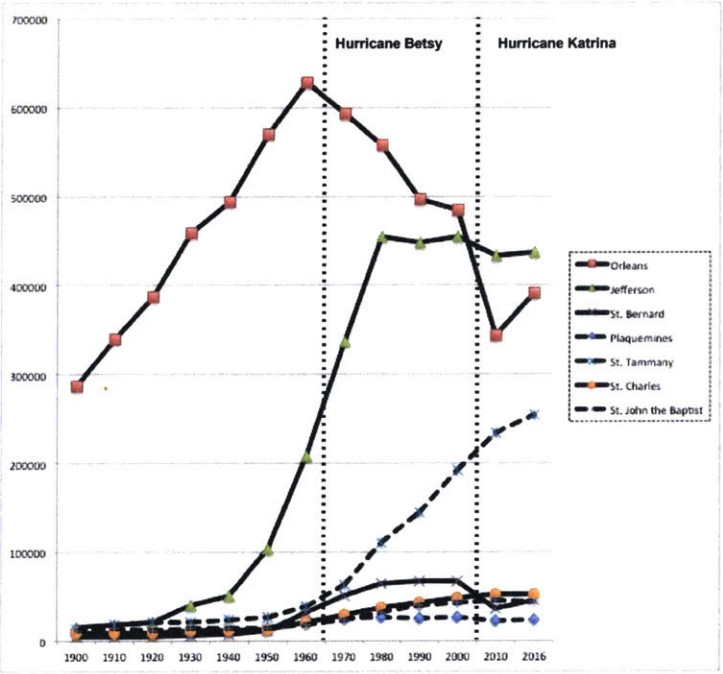

Figure 4.7. Population by parish. The population in the largely levee protected parishes of Orleans and Jefferson have been stable or declined in recent decades while non-levee protected St. Tammany Parish has grown the fastest of any parish in the MSA.

The decoupling of growth from levee investments again complicates the straightforward structural expectations of the 'growth machine' hypothesis. These growth dynamics were driven by inter-jurisdictional competition, broader socio-political trends, and investments in other, non-flood related infrastructures. The growth in outside parishes can be largely attributed to accelerating suburbanization tied to "white flight" spurred by school desegregation and new road and bridge infrastructure. New Orleans public schools were desegregated in 1960. As in other American cities, this desegregation process accelerated a pre-existing suburbanization trend as white residents sought to reestablish de facto segregation by moving to largely non-integrated suburban parishes. This process of suburbanization was fueled by state and federal investments in new highway and bridge infrastructure. The Lake Pontchartrain Causeway linking New Orleans to the "Northshore" communities in St. Tammany Parish opened in 1956. While public and private boosters of development in eastern New Orleans expected that the completion of Interstate 10 would be a driver of growth in the area, the 1965 completion of the I-10 Twinspan bridges also connected New Orleans to Slidell and other eastern suburbs, further accelerating suburbanization. Thus, hopes for using levees to channel regional growth into New Orleans were overcome by the broader trends linked to racial politics and automobile-fueled suburbanization.

To make sense of how levees shape uneven vulnerability in these outside suburbs, the concepts of facilitation and marginalization from the political ecology of hazards provide a useful starting point (Collins 2010). In interviews, residents of some suburban areas outside of the newly reinforced post-Katrina flood gates and levees indicated that they were being marginalized when they spoke of being "walled off," "locked out," and "shut off" by the protections. One resident of Venetian Isles (Figure 4.8), the waterfront "Florida-type" suburb developed outside the levees by New Orleans East Inc. reported,

> Of course, the city proper is stronger and better with their levees and pump systems, but you know I just think it is really unfortunate that they have done absolutely nothing to protect areas like us.

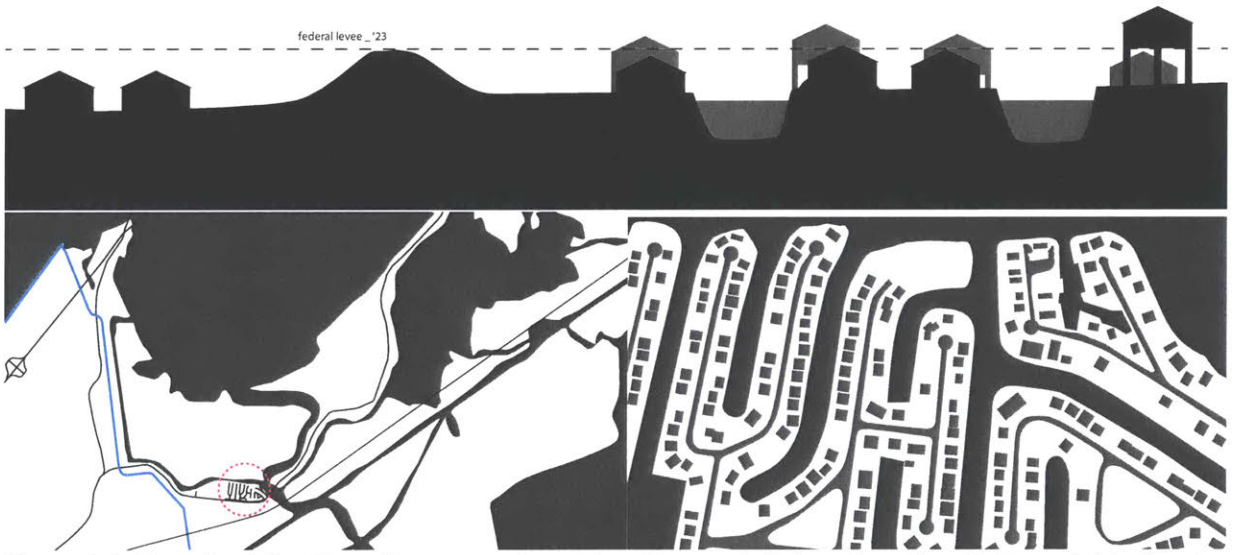

Figure 4.8. Venetian Isles. Top: diagrammatic section; Bottom left: location plan; Bottom right: site plan.

While the post-Katrina fortifications have left outside residents feeling marginalized, these areas largely do not fit Collins' image of marginalized communities wherein, "the least powerful groups and classes in a given society inhabit the most hazardous environments"(Collins 2008). In fact, the suburban

communities outside of New Orleans' levees are generally more white and more prosperous than areas inside the levees. In 2010, the average household in the census tract that includes Venetian Isles (whose western boundary is aligned with the levee) earned $53,472, more than double the average household in the adjacent inside census tract ($21,452) and approximately 43% more than the average household in Orleans Parish at large ($37,325). Similarly, the poverty rate for the outside census tract (6.6%) was less than half of the tract on the protected side of the levee (15.4%) and nearly a fourth of that in the parish as a whole (25.75%). While the African-American portion of the populations of Orleans Parish and the adjacent inside census tract are approximately 60% and 73% respectively, there was not a single African-American counted among the residents of Venetian Isles' census tract in 2010.

Overall, the parishes that are outside the hurricane protection levees are also whiter and more prosperous than those that are substantially protected by the levees. In 2016, the outside parishes (St. Tammany, St. John the Baptist, and Plaquemines) were 18% African American while those inside (Orleans, Jefferson, St. Charles, and St. Bernard) were 40%. Similarly, outside parishes had a combined poverty rate of 12% while those inside levee protection had a poverty rate of 20%.

While several residents of suburbs outside of the levees reported feeling marginalized by the newly reinforced flood protections around New Orleans, these settlements are substantially facilitated in inhabiting their flood prone landscapes by other government programs, most notably the National Flood Insurance Program. Though many residents of Venetian Isles and other outside suburbs have flooded repeatedly in recent years, the subsidized NFIP has enabled these properties to remain in place, often without substantially mitigating their risk of future flooding. The dependence of these communities on heavily subsidized flood insurance was clear in interviews with residents of suburban communities outside of the levees. At the time of interviews in 2014, there was ongoing political uncertainty surrounding congressional efforts to reform the NFIP to lower subsidies, bringing premiums closer to actuarial rates. Speaking to the impact of this reform effort in creating uncertainty in real estate markets, one Venetian Isles resident said,

> You can't sell your home. You don't know what's happening to your flood insurance... Like the man around the corner tried to sell his house, and there was a big issue with the flood insurance. Even though it hasn't become law, there is a lot of uncertainty out there. So you have the real estate market flipping out and you have all these people unsure.

The uncertainty in real estate markets caused by these reforms is an indication that, even as the levees may physically marginalize some communities, subsidized flood insurance facilitates their persistence. Thus, with fragmented and multi-layered governance, the state may simultaneously facilitate and marginalize different communities using disparate mechanisms.

Adapting, and Not Adapting, to Life Outside the Levees

A behavioral reading of the relationship between the hurricane protection levees and settlement patterns in the outside suburbs is also more complex than a simple behavioral model like the 'levee effect' would suggest. Where the late 20th century levees and pumps clearly enabled poorly adapted settlement patterns in eastern New Orleans, the relationship between flood hazard exposure and household level risk perception and adaptation is complex and varied.

Many residents of outside suburbs reported feeling that, in spite of the increasing severity of flooding, their neighborhoods were actually safer than areas inside the hurricane protection levees. One resident reported,

> One thing unique about this neighborhood, normally the water comes and goes, in and out. So even though it causes damage, it's gone. Because it naturally recedes. Unlike in the levees that have to be pumped.

The perception that levees may actually make vulnerability worse was tied to a general distrust of the USACE and their scientific and engineering knowledge. One Venetian Isles resident said,

> I am not a big fan of the Corps of Engineers. You know, a lot of the projects they do, even with all of their knowledge, they just, they seem to make things worse.

Some residents of areas outside the levees reported adapting their structures to flood risk based on knowledge gained from their own experience or that of their neighbors. One resident told me,

> I took all the information that I could when I decided to build. I knew the old man who was still living there [next door]. He showed me where the water got to in Camille on his property... He showed me where it came on his slab and I built 20 inches higher. And I figured I was safe, because Camille was a pretty bad hurricane.

When asked about their relative flood risk, some residents of the outside suburbs made a link to broader issues of security, including crime. One Venetian Isles resident stressed this point, saying

> It was a safe place to raise a family. There aren't a whole lot of safe places to raise a family in Orleans Parish. And, especially if you have kids...It's safe...We don't even lock our doors. You can't do that many places in the city. Not even in the suburbs.

While some residents of outside suburbs reported feeling that their neighborhood was relatively safer than those inside levee protection and took it upon themselves to proactively adapt their homes to the flood exposure of the area, many did not. Many homes in outside suburbs retain conventional suburban building styles that would be at home in levee-protected suburbs. While this tendency to resist adaptation is likely partially attributable to the facilitation effects of subsidized flood insurance, there are other factors at play as well. Even as they were drawn to living outside the city's flood protection system, several interview subjects in Venetian Isles and other outside suburban areas referenced their desire to live in "New Orleans-style" or "French Quarter-type" homes. One resident of Braithwaite, a town in Plaquemines Parish just outside of New Orleans' levee protections reported that, though they chose to elevate their house some 19 feet after flooding during 2012's Hurricane Isaac, they built a false front on the house to make it look like a slab-on-grade home. Averse to living in a house that looked like a "camp," the name used for elevated structures in rural south Louisiana, they said,

> I did not want a house on pilings that... I wanted it to look like a house. I didn't want it to look like a camp.

For many residents of more suburban communities outside the levees, elevated building types were associated with backwardness and poverty. Among those who did choose to elevate their homes, many employed a suite of techniques to disguise their elevation. These strategies included: abandoned first floors; stage set-like false front walls on elevated homes; and mounded earth under or in front of homes (Figure 4.9). The resistance to elevating buildings and attempts to hide elevation via various masking techniques suggest an *anti-adaptive bias*, which complicates the expectations of an orthodox reading of the levee effect, wherein people outside of levee protection would be expected to embrace greater adaptation.

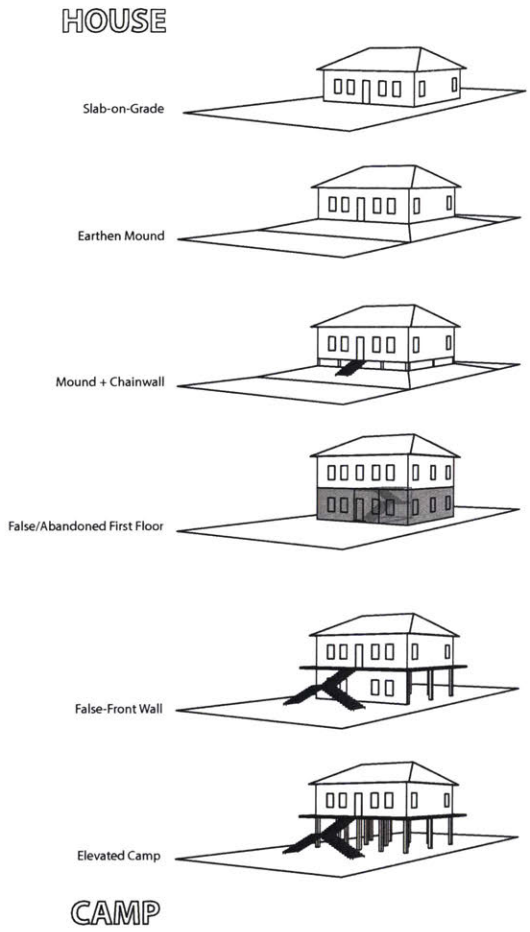

Figure 4.9. Anti-adaptive bias. Hiding elevation.

If these anti-adaptive tendencies represent "uncooperative people," not behaving as models anticipate, the vulnerability of outside settlements is also shaped by "uncooperative natures." These settlements are especially vulnerable to hurricanes and other coastal storms, which are more frequent and severe due to climate-change. The growing suburban communities outside of levee protection are especially exposed to flooding because of severe coastal land loss caused by the river levees, canal dredging, and other processes (Coastal Protection and Restoration Authority 2012). Speaking to the increasing vulnerability of outside communities, one Venetian Isles resident said,

> If they don't start doing something with the coastline out here, you're not going to have to worry about it, because it's going to be gone. We are watching erosion out here. Since I've been here, I've seen city blocks of erosion not feet of erosion.

For the growing population of suburban areas outside of New Orleans' hurricane protection levees, unruly natures responding in inconvenient ways to human interventions are exacerbating the vulnerability of living outside of structural flood protections.

The Batture

During the Great Depression, waves of job seekers arrived in New Orleans. Some built their own homes from driftwood and other salvaged materials along the edge of the Mississippi River, on the outside the city's levees. At its peak the riverside "Depression Colony" included some 400 homes. The area has

come to be known as "The Batture," term for the riverside landscape where the houses were built. From its early days, the settlement has always been a place apart from the city on the dry side of the levees. The "New Orleans City Guide," produced by the New Deal-funded Federal Writers' Project in 1938, described the adaptations of the Batture to the flood prone landscape saying,

> The houses are built on stilts and are safe from all but the highest flood stages... When the water rises, the livestock is taken up on the little galleries that run at least part way around each house and the occupants remain at home until 'Ole Man River' becomes too dangerous. (Federal Writers' Project et al. 1938)

While the Batture provided an inexpensive housing option for several decades, the expansion of riverfront port and levee infrastructure periodically forced the displacement of Batture residents. From its peak in the 1950s, the Batture shrank from roughly 400 households to only 12 today, strung along the Mississippi River levee just upriver from the Orleans-Jefferson Parish line (Figure 4.10). When, in the 1950s, the USACE enlarged the levees in this area, much of the settlement was destroyed and its residents were evicted and, in some cases, relocated to new public housing projects. A 1954 USACE plan for levee works shows dozens of Batture dwellings and includes a note that "Buildings within the work area will be removed by others prior to the commencement of work" (US Army Corps of Engineers District, New Orleans 1954).

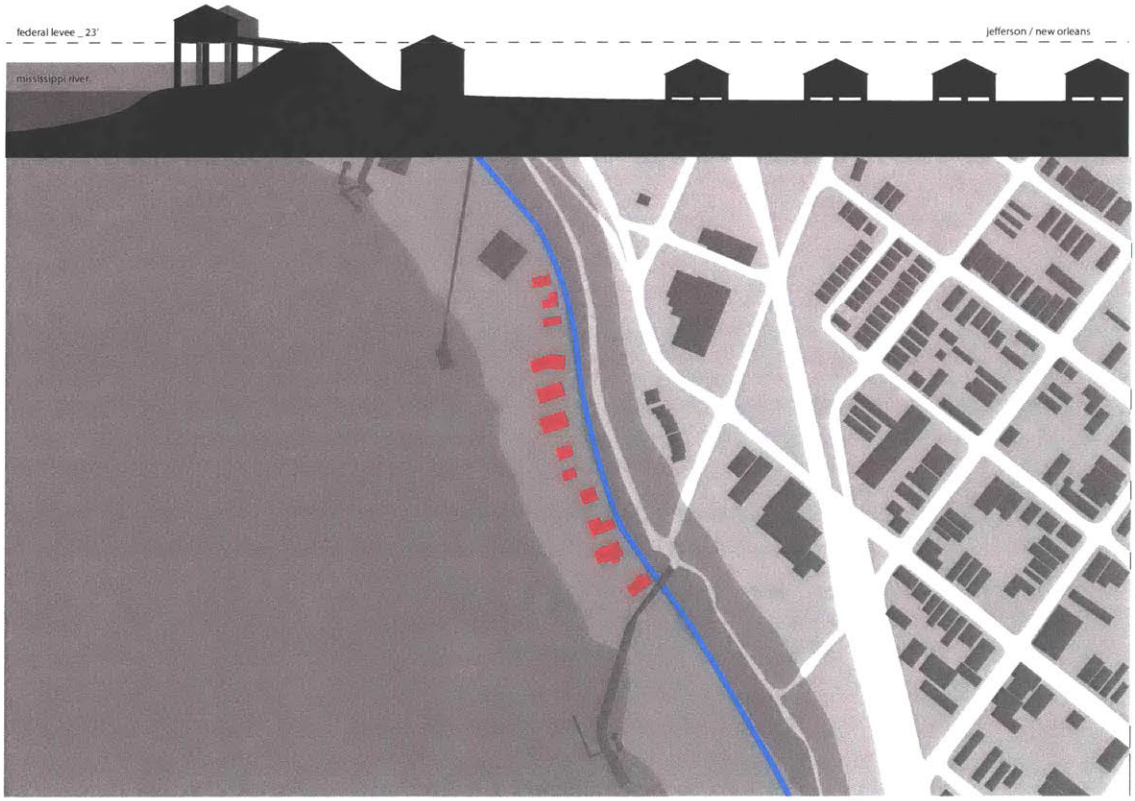

Figure 4.10. The Batture. Top: diagrammatic section. Bottom: context plan.

Today, as in the 1930s, most Batture houses are elevated on wooden pilings above the sandy riverbank. The relative advantage of the Batture's location and the adaptation of its houses were clearly demonstrated in 2005 during Hurricane Katrina. While 80% of the city was inundated by floodwaters that took weeks to drain (Van Heerden 2007), Batture houses sustained no flood damage and were only minimally affected by the storm's winds. In interviews, several current Batture residents reported that

they were less vulnerable to flooding than were the neighborhoods immediately inside the city's levees. One resident told me "the risk is on the other side of the levees." Another concurred saying,

> If a hurricane comes, I'm outside the levee, I'm safer on this side than I am on the other side. Because if a hurricane floods the city, the water don't go out. [On the Batture] the water goes right back down the river. I'm going to be fine.

This viewpoint, seen here and in other outside settlements, reflects the idea that, some people choose to "opt out" of collective protections, voluntarily removing themselves from flood protection because, as Kai Erikson suggests, they distrust "complex technologies [that] cannot be relied upon" to mitigate risks (Erikson 1994). For these Batture residents, the known dynamism of the riverfront landscape is preferable to relying on engineered flood protections that they regard as brittle and untrustworthy.

While the Batture once contained a range of shacks and floating houseboats, the remaining houses in the area are built on stilts. The elevation of most houses in New Orleans (as in any flood prone region in the US) is guided by the Base Flood Elevation (BFE), a regulatory benchmark created by FEMA to determine rates and coverage requirements for subsidized flood insurance. Recognizing that they face a higher exposure to flooding than their inside neighbors, Batture dwellers build their houses much higher than the BFE in the area inside the levees, frequently aligning their floor levels with the top of the adjacent levee. This configuration is based on the logic that the Corps of Engineers will take extreme measures to keep the Mississippi River from approaching the top of the levee in order to protect the city, saving Batture houses in the process. One resident explained,

> The safest assumption is that they don't give a damn if I flood. But, above seventeen and a half feet river flood stage, historically they have … opened diversion projects like the Bonne Carre Spillway [to lower the river level].

Treating the levee as a datum against which they measure their own adaptation, Batture dwellers consider themselves to be uniquely well adapted. One resident told me,

> I am therefore the highest house in New Orleans. This is my floor level and you are looking at the roofs over there [inside the levee]…I cannot flood. Once in a while when the river is up, they send the TV people out to interview us. And they always say, "Did you ever get water in your house yet?" and I always say... my stock answer is, "The day I get water in my house, the city of New Orleans is gone."

Batture dwellers have adapted their settlement to the particular natural and technologically manipulated hydraulic conditions of their site outside the levees. However, they have always been, and remain vulnerable to hostile legal and regulatory regimes. The vast majority of Batture houses were destroyed over the course of the late 20th century formalization of New Orleans' flood control regimes. The remaining households in the Batture occupy an ambiguous legal landscape. Residents have a measure of de facto recognition in that they receive mail, electricity, and municipal water supply ("Batture Property Rights in Question" n.d.). However, they do not have titles to their land and cannot legally transfer ownership or use their property as collateral. In recent years, this lack of full tenure security has invited challenges from private parties claiming ownership to the lands under their homes ("Batture Property Rights in Question" n.d., *Grand Theft on the Mississippi River Batture. Part I: Introduction* 2012). Several residents (both those who agreed to be interviewed and some who did not) indicated in personal communications that residents would be wary of speaking to an outside researcher due to the ongoing legal battles. While the Batture settlement only exists because the ambiguous legal status of riverfront land enabled the area's settlement by poor people, that same ambiguity has been the source of their greatest vulnerability. Though Batture dwellers have become well practiced at reading and responding to seasonal cycles and the Corps of Engineers' manipulations of the river's floodwaters, eviction drives from Levee Boards, the Corps, and, now, wealthy private

claimants have posed a bigger threat to their settlement.

The persistence of the remaining households on the Batture may be partially attributable to their changing demographics. From its roots as an informally settled Depression camp through much of the 20th century, the Batture was home to a racially mixed group of low-income residents, many of whom earned their livelihood on the river. Historical accounts and interviews with current residents depict a settlement that was home to deck hands, port workers, and fishermen. While today's Batture residents are an eclectic group, as compared to the Batture residents of the past and as compared to residents of the surrounding census tract, they are considerably more prosperous and whiter. Because the census block boundaries do not follow the levee at the Batture, there is no official demographic data for residents of the area. However, site observation and interviews with residents revealed that all of the Batture's residents are Caucasian while the census tract in which they are located is approximately 27% African-American. The census tract had a mean household income of $37,443 and a 28% poverty rate in 2010. While there is no reliable data on the income of Batture residents, interviews indicate that the group includes doctors, teachers, musicians, artists, and several retired people. Some residents reported an increase in the income, socio-economic status, and formality of housing in recent years. The recent construction of a large and more formal home by one Batture resident raised the ire of others in the area, because the new house changed the visual character of the settlement and existing residents worried that the new house would draw the attention of outsiders who might threaten the continued existence of the settlement. Another Batture camp was recently taken over as a retreat and party space by one of the city's wealthiest citizens. While the Batture was once a settlement site of last resort for some of the city's poorest residents, today the cluster of wooden camps nestled in the riverside willow trees is prized for its odd charm. Though the settlement might once have been representative of a type of infrastructural marginalization, that characterization no longer fits.

The Mississippi River levee defines the Batture. Hydraulically, the Batture exists outside of the technical protections of levees and pumps, encouraging residents to adapt to the natural and technically-manipulated water levels of the river. Practically, the levee and its gravel-topped road provide access to the Batture's camps. Legally, the levee creates the area's ambiguous status, which has been simultaneously essential to its settlement and central to its legal vulnerability. With this legal ambiguity, Batture dwellers have largely remained outside of the conventional regimes of commodified risk and urban property relations. They cannot access traditional sources of financing or insurance and thus must develop their own risk mitigation strategies in both their building practices and their behaviors. The levee defines a datum against which Batture dwellers measure their flood risk, motivating them to build their houses to the height of the levee top and assuring them that the USACE's technical manipulation of the river on behalf of the city will keep them safe as a happy byproduct. As in eastern New Orleans and in the suburban areas outside the levees, the levees are an essential component of defining settlement patterns and vulnerability on the Batture. However, in all of these cases it is not the spatial and material qualities of the levees themselves so much as the relationship between the levees and the broader socio-technical ensembles in which they are embedded, the levee complexes, that is most important.

The following sections shift from New Orleans to Dhaka. They consider how the 20th dry city infrastructures built in Dhaka have become enmeshed in their own distinct and dynamic levee complexes, creating very different patterns of urbanization and very different patterns of uneven vulnerability.

Dhaka: Flood Embankments as Spines of Urbanization

As explained in Chapter 3, dry city infrastructural modernization was promoted in Dhaka by a string of foreign engineers and development consultants. In the years following the end of British colonial rule, the World War II military contractors-turned-development specialists who were dubbed "Ambassadors with Bulldozers" by that 1954 *Time Magazine* cover, partnered with representatives of US hydraulic bureaucracies like the TVA and the USACE and nascent international development institutions like the UN and the World Bank to bring water infrastructural modernization to the eastern Bengal delta. While New Orleans had relied on structural flood protections since its founding, Dhaka did not embrace such a system until the early 1990s. For much of Dhaka's 400 year history, the city's leaders and residents had coped with the seasonal flooding as those in other settlements throughout the delta did, through a combination of: strategic settlement patterns in relatively elevated areas; a distributed system of canals, ponds, and tanks; and a built environment in which the vast majority of structures were relatively low cost, light weight, impermanent, or floodable.

First under a 'crash programme' and later with the support of the World Bank-supported Flood Action Plan, the Bangladeshi government built a system of embankments and pumps for western Dhaka following consecutive years of heavy flooding in the 1980s. Dhaka's levee boosters expected that the combination of flooding and drainage infrastructure with land use and building regulations would define new edges to urbanization, enforcing a new spatial discipline on the city's growth. However, a combination of environmental, governance, and demographic factors have coalesced to undermine the power of the levees to define distinct hydrological and urban spatial regimes. Enormous development pressure, ineffective drainage within the levees, and unenforced land use and building regulations have driven Dhaka's flood control infrastructure to shape urbanization in unexpected ways.

When considering the role that Dhaka's levees have played in shaping the city's uneven vulnerability, two points are critical to recognize. First, as in New Orleans, the ways in which Dhaka's dry city infrastructure has shaped uneven flood risk are a product of often unexpected, emergent, and dynamic relationship between those infrastructures and other elements of their associated socio-technical ensembles. Second, in the midst of the rapid, uneven, and often violent processes of urbanization taking place in Dhaka, flood vulnerability must be seen as one among myriad threats to the lives, health, and livelihoods of the urban region's poor.

The following sections describe how Dhaka's late 20th century dry city infrastructures have been absorbed into the broader processes of urbanization, contributing to uneven landscapes of vulnerability. As with New Orleans, the following sections briefly describe three particularly levee-impacted settlements. The sites include one area inside levee protection (the western Dhaka polder) and two areas outside levee protection, one more or less formal (eastern fringe development) and one more or less informal (Kamrangichar) (Figure 4.11).

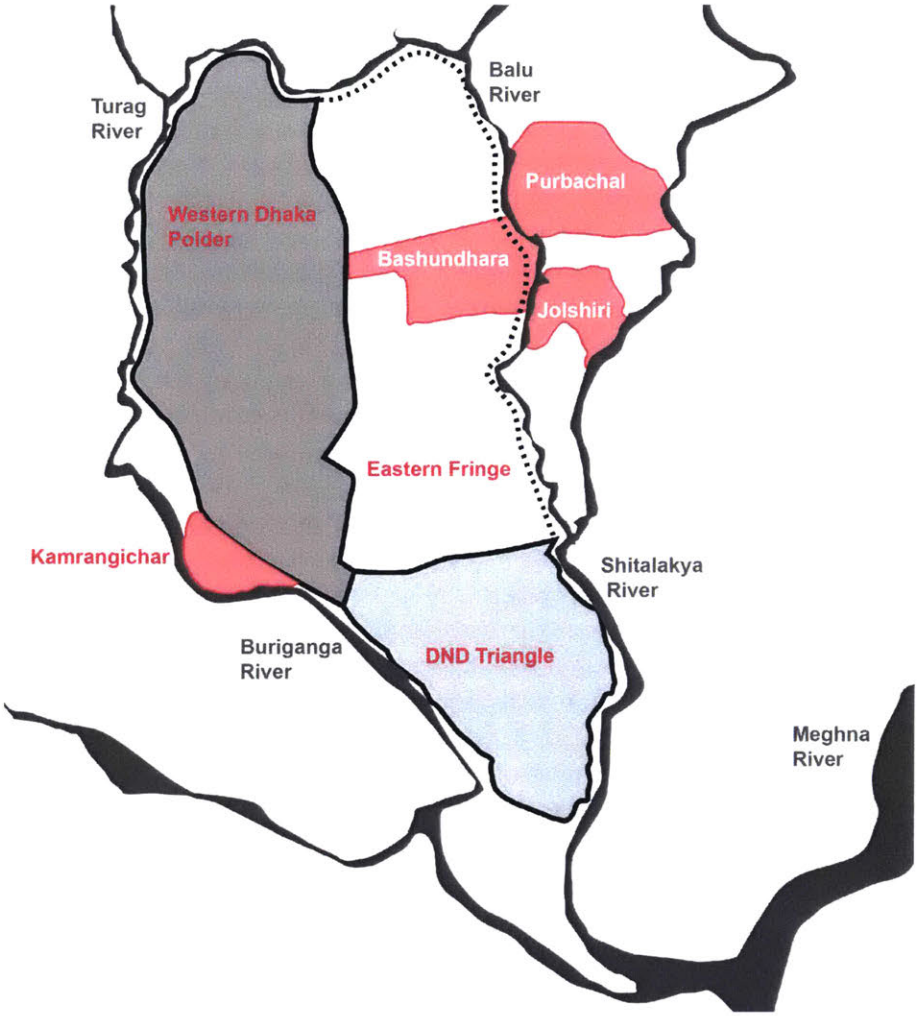

Figure 4.11. Dhaka sites and embankments, built (western and DND) and proposed (eastern)

Dhaka's Embankments: reducing one type of flooding while causing another

As intended, the western embankment has provided protection from inundation from "outside" floods during recent high water years (e.g., 1998 and 2004) (F. Ahmed et al. 2015), sparing much of the protected territory from damage from overflowing rivers. However, in spite of the investments in sluice gates and ever-increasing mechanical pumping capacity, waterlogging remains a persistent and worsening problem within Dhaka's western embankments. The regular newspaper stories and photos depicting monsoon season waterlogging, clearly show that the embankments were not the "permanent solution to the flood problem" promoted by planners and project boosters (*Bangladesh Observer* 1988c). Mirroring the opinions of some residents outside of New Orleans' levees, interviews with residents on both sides of the western embankment indicate that many do not perceive of inside areas as appreciably more "flood free" than those outside the levees. Rather, many reported that the relative flood risk outside is actually lower given the regular waterlogging of inside areas and the relatively infrequent incidence of river flooding outside.

The first encompassing structural flood protections built in the Dhaka metropolitan area were built in the era of the post-colonial "Ambassadors with Bulldozers." Just two years after the UN's Krug Commission report put forward a vision for water infrastructural modernization for East Pakistan, the Dacca-Narayanganj-Demra (DND) project was begun in 1961. The effort was funded by the International

Development Association (IDA), which had only been founded just the previous year. The project included flood control embankments surrounding approximately 16,800 acres of agricultural land south of the urbanized area of Dhaka. Like many other delta water infrastructure projects of the era, the DND project sought to control the flow of water onto agricultural fields to allow farmers to grow three crops per year rather than the one or two crops they grew under existing hydrological conditions. The project included embankments to keep floodwater out of the polder, along with irrigation canals and small pumps that could both remove rainwater during the rainy season and supply river water to irrigate the poldered fields during the dry season. The project was overseen by the EPWAPDA, the agency set up in 1958 following the recommendations of the Krug Commission. The US-based International Engineering Corporation (IECO), which would later develop the influential EPWAPDA Master Plan, was the main engineering consultant.

Like other agricultural focused projects of this era, the DND project was premised on the idea that rural farmers would be eager participants in the project. The proposal states that, "To obtain the full benefit from the project, farmers will have to make changes in their system of farming" (International Development Association 1961). While they expected farmers to rapidly adjust their long-established practices to take advantage of the new production potential, planners did not foresee that the new hydrological regime, paired with broader urbanization dynamics might invite changes in the area's land uses. The project area was directly adjacent to the largest urban agglomeration in the province and the proposal states that the project area was, at the time, "densely populated and on the fringe of a considerable industrial and urban development" (International Development Association 1961). Notwithstanding the adjacent urbanization, the DND project, like the Krug Commission before it, was guided by a single-minded focus on increasing agricultural production. In the map from the IDA proposal, the only features portrayed include hydrological features and existing and proposed infrastructure. The map completely omits any indication of the location, form, or size of human settlements (Figure 4.12).

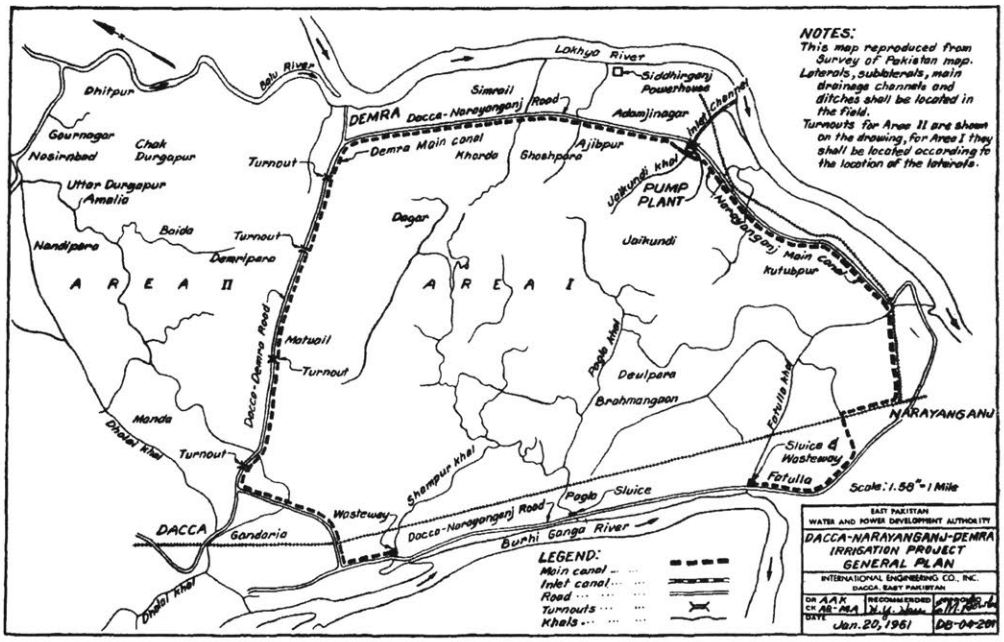

Figure 4.12. DND Embankment Plan (World Bank, 1961). Completely omits settlements.

In the years since the construction of the DND embankments, the population of the area has exploded and the area has been transformed from a landscape of seasonally flooded agricultural land into a dense zone of rapid unplanned urbanization. Because the area is protected from regular river flooding by embankments, most construction is not elevated above flood levels. As such, the area's residents are frequently threatened by flooding from both internal waterlogging and external river flooding (in the event of a levee failure). As the population of the area has increased, land use has changed from agricultural to urban and much of the drainage infrastructure has been compromised by urban development, subjecting the area to regular waterlogging.

The DND project has become a frequently cited example of the unintended consequences of structural flood protection in the Bengal delta (e.g., Brammer 2000; Rasid and Mallik 1993). In interviews, planners and engineers familiar with Dhaka's flood mitigation efforts often referred to the DND project as an object lesson in the problems with instituting a dry city infrastructure approach for Dhaka. One international consultant with extensive experience on flood management projects in Bangladesh said that the DND project "turned into a total nightmare" (Oberhagemann 2017). A RAJUK planner reported,

> The DND project is a very bad experience for Dhaka people... the project was taken for agricultural purposes but now the agriculture has stopped and urbanization has taken over. The waterlogging problem in this area is very severe. Now whenever the government wants to take embankment projects... there is lots of debate. (Kabir 2017)

A longtime manager with the BWDB spoke of the DND project as an instance of the levee effect at work, saying that people moving to the newly empoldered area did not elevate their homes adequately "because people thought that it was a flood protected area." Then, "suddenly, they were underwater." This official, like other engineers blamed the problems with the DND project, not on poor planning or inappropriate technology, but on the people in the area, saying "they themselves created the obstructions of drainage" that cause the waterlogging problems in the area (M. Zaman 2017). Another senior water expert told me that the DND infrastructure "was a great project," but that the problems arose because "the canal network was not maintained" (Nishat 2017). A senior water engineer reported that the waterlogging problems in the DND area "can be solved very easily, but with lots of investment" because the area's "pump house should have triple capacity" (M. Zaman 2017). Each of these comments recognizes that the DND project has gone terribly awry. However, in each case, the problems in the area are framed in narrow techno-managerial terms. In this view, it is not that the project was fundamentally wrong-headed or inappropriate from its conception. Rather, unruly people have behaved inappropriately, settling in unanticipated ways, spoiling a great technical project, and requiring a doubling down on dry city infrastructural solutions.

The DND embankments built in the 1960s previewed many of the problems that have characterized the larger embankments built around western Dhaka following the floods of the late 1980s. The DND embankments simultaneously induced urban development in a territory previously subject to seasonal river flooding and blocked existing drainage pathways, causing extensive waterlogging from rain flooding. From the earliest days of Dhaka's western embankments, critics have charged that they too have caused many in Dhaka to live "at the edge of stagnant water" (Rasid and Mallik 1996).

Though the initial dry city plans produced by the FAP called for setting aside large areas of low-lying land for stormwater retention within the embankments, much of the land was not acquired and has been gradually overtaken by expanding urban settlement. By enabling the spread of urban settlement into low-lying areas, the western embankments have set off a path-dependent process wherein the city is ever more reliant on pumped drainage. As more wetlands are urbanized, the western polder has less

capacity to retain and infiltrate stormwater, requiring ever more pumping capacity. Though the embankment has been in place for less than thirty years, the pumping station at Goramchatbari was required to install first a second and then, more recently, a third pump house in 2017 (Figure 4.13). As in the DND case, officials and engineers tend to blame "encroachment" and illegal dumping into canals and retention areas for the inadequacy of the city's drainage system, rather than regarding the design of the system as inappropriate to the urbanization conditions and governance capacities of the context.

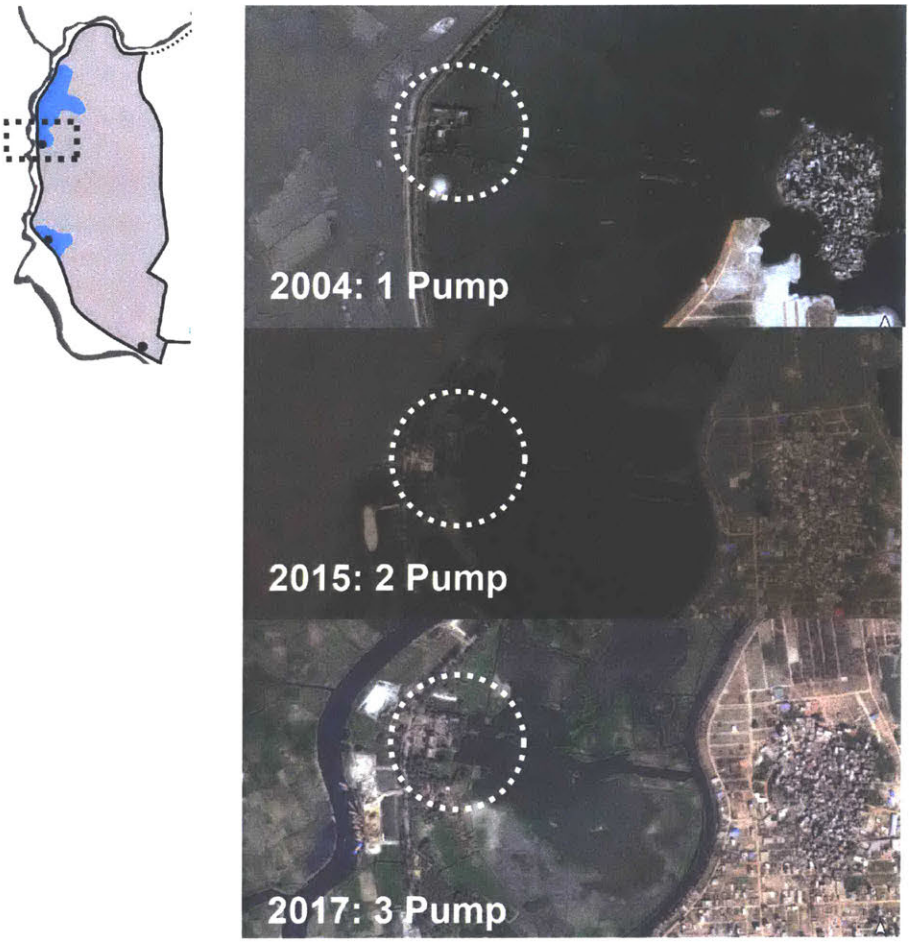

Figure 4.13. Path-dependence and positive feedback. Landfilling inside the western embankment drives the need for increased pumping capacity at Goramchatbari pump station.

While the levee-enabled expansion of urban settlements in western Dhaka is broadly parallel to the pattern observed in eastern New Orleans, there are some important differences to note. Eastern New Orleans dry city infrastructure allowed for the expansion of the city into areas that were previously largely uninhabited and enabled patterns of risk-blind suburban development in-line with visions of modern suburban development in the late 20th century, including a shift from traditional elevated architectural forms to slab-on-grade houses. The vulnerability generated by this levee effect was clearly demonstrated when the levees broke during Katrina. As Dhaka faced rapid population growth and severe limitations on naturally elevated land for development, the western embankments have similarly enabled the expansion of urban settlements. However, because the mechanical drainage systems of the city have never operated adequately to evacuate heavy rainfall, architectural patterns have changed less in Dhaka. As one planner told me, "even after the embankment was built, the people continue to fill up the land to the level of the embankment," because "they do not trust the government system"

(Chaudhury 2017). Among the most common residential building typologies in middle class and prosperous neighborhoods of the city are midrise apartment blocks with the ground floor occupied by parking and utility space, elevating living space to avoid periodic waterlogging (Figure 4.14).

Figure 4.14. Elevated apartment block with ground floor parking inside Dhaka's western embankment.

Many of Dhaka's hundreds of fragmented informal settlements are in low-lying areas within the western embankments (Centre for Urban Studies (CUS) 2006). Residents of these low-income settlements also rely on a combination of landfilling (typically incremental filling using whatever fill material is available) and structure elevation (often on bamboo poles) to reduce flood vulnerability (Figure 4.15).

Figure 4.15. Elevated dwellings in informal settlements inside Dhaka's western embankments.

For both prosperous and low-income residential areas within the embankments, the persistent threat of waterlogging in Dhaka's western embankment has dampened the levee effect by reducing the tendency for residents to 'forget' the flood hazards of the area. As was the case in the Batture, in interviews with residents of areas outside of Dhaka's western embankments, several reported that areas inside the protections were actually more vulnerable to flooding than those outside. While some outside residents recognized that they were more exposed to river flooding, such events are relatively infrequent. There had not been a substantial river flood in Dhaka in several years preceding my fieldwork (which took place between 2014 and 2017). However, waterlogging within the embankments is a perennial problem with low-lying areas regularly saturated with foul-smelling waters during the annual rainy season. The final two cases present different circumstances in which Dhaka's embankments have shaped life outside of their zones of protection.

Kamrangichar: Rapid urbanization in a twice marginalized settlement outside Dhaka's embankment
While the area inside Dhaka's western embankments has seen intensification of urban development in recent decades, many areas outside of the levees have also been substantially urbanized. Though much of the 'outside' urbanization is technically illegal in the eyes of Dhaka's land use plans, large areas have been transformed from seasonally flooded wetlands and agricultural lands into residential districts. Some of this urbanization has taken the form of small-scale informal filling and settlement while in other areas, powerful developers are undertaking massive landfill-based land reclamation schemes.

The portion of Dhaka's western embankments that run along the Turag and Buriganga rivers to the north, west, and south of the city simultaneously marginalized communities that were outside the chosen alignment and facilitated their growth and expansion by providing improved access through the ring road built atop the levee. The embankment built under Ershad's "crash programme" in the early 1990s largely followed the alignment defined in a 1970 study by the British engineering firm Halcrow (Figure 4.16).

However, when the embankment was built in the early 1990s, the alignment was shifted in two important ways. First, only the western portion of the city was encircled in embankments. Second, along one stretch of the Buriganga riverfront, the alignment was shifted to exclude a large area of riverfront land, including one area known as *Kamrangichar*. *Kamrangi* is the Bengali name for a type of citrus fruit like a large grapefruit. *Chars* are the sandbar islands that are threaded through the Bengal delta's braided river channels. For much of Kamrangichar's existence, it was separated from the mainland city by a small water channel. Like other chars in the eastern delta, it was a largely rural settlement. However, with massive in-migration to Dhaka over the course of the 20th century, Kamrangichar was converted from a rural landscape to a dense and largely informal urban settlement. By 1991, when the embankments were being completed, there were some 35,000 people living there (Japan International Cooperation Agency 1991).

Though Kamrangichar was entirely inundated by the 1988 floods, the "crash programme" embankments did not to include the area in the zone of protection. The floodwalls and earthen embankments for the area downriver from Kamrangichar hug close to the existing urbanized waterfront. When the embankments reach Kamrangichar, they cut inland and run along the 'mainland' shore rather than reaching out to include the char land (Figure 4.16).

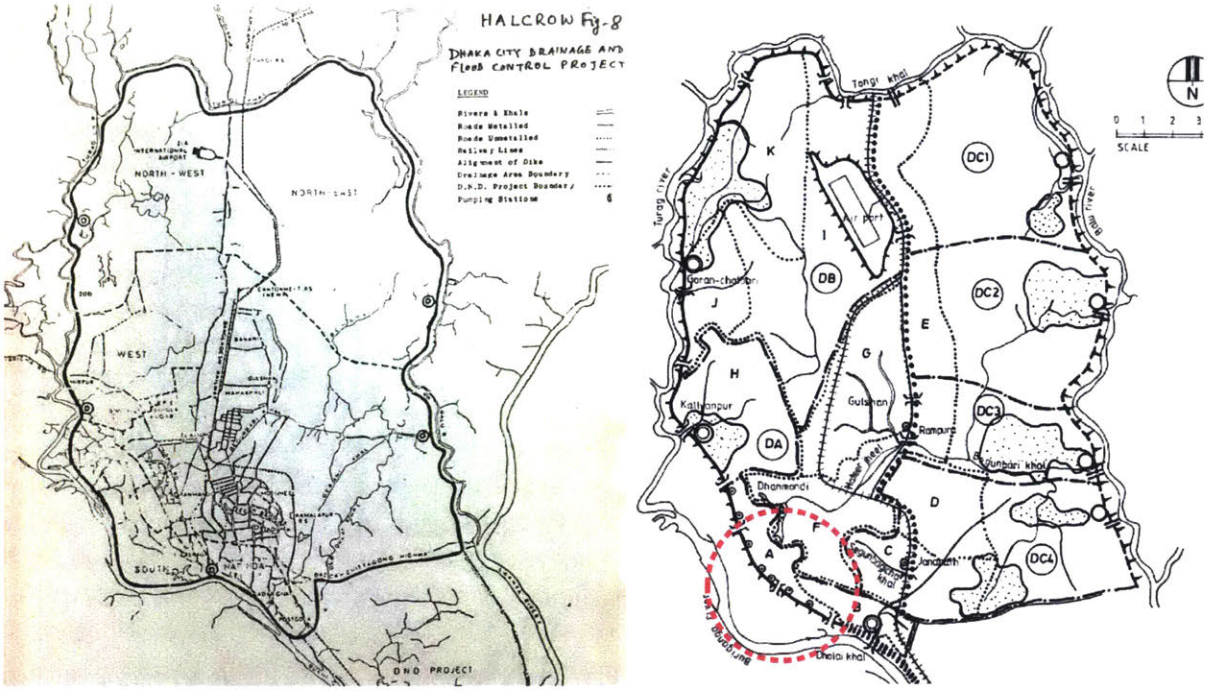

Figure 4.16. Left: 1970 Dhaka embankment proposal by Halcrow. Includes embankment around Kamrangichar. Right: Kamrangichar excluded from western embankment as built under the 'crash programme' and FAP. (FAP 8b)

While the alignment reduced the overall length of the new western embankment, it also excluded the mostly poor residents from the new protections. The FAP 8b study formalized the crash programme's exclusionary alignment calling for the temporary levees to be reinforced in place. In fact, the study report does not even mention Kamrangichar. The FAP 8a flood protection master plan for Dhaka considers multiple options for how the char might be incorporated into the city's flood defenses, in the end calling for an independent poldering of the land and the construction of dedicated pump stations to remove internal stormwater (Japan International Cooperation Agency 1991). To date, this polder and pumping system has not been built. Thus, Kamrangichar has been doubly marginalized by flood infrastructure: first, through the exclusionary alignment and then by the failure of authorities to follow through on plans for independent infrastructure for the area.

In the 15 years after the 1991 FAP studies, the population of Kamrangichar grew roughly ten-fold. By 2006, the area was home to some 300,000 people, the majority of whom were classified as "slum dwellers" (Centre for Urban Studies (CUS) 2006). Today Kamrangichar is a bustling, high-density urban district, home to small industrial outfits, paved streets, and active shopping areas. The narrow channel that once separated the area from the rest of Dhaka has been completely filled in some places and is choked by garbage and water hyacinth in others. The area provides relatively affordable housing and livelihood opportunities for a range of residents from students at the nearby universities to migrants newly arrived from rural districts.

The story of Kamrangichar's flood infrastructure illustrates many of the larger themes evident in the Dhaka region. Though the area has seen a dramatic increase in density and population in recent decades, it still remains marginalized infrastructurally and politically. Though residents reported major inundation in 1998's floods, academic studies of Dhaka's flooding in that year literally left Kamrangichar (as well as other urbanizing areas across the rivers from the core of Dhaka city) off the map (Mohit and

Akhter 2000) (Figure 4.17). While the area is among the densest parts of the urban region, Kamrangichar was only officially incorporated into the Dhaka City Corporation (South) municipal area in 2015.

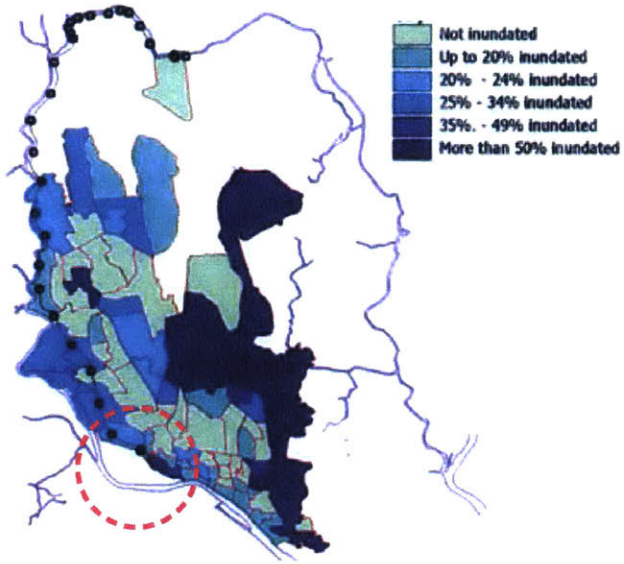

Figure 4.17. Inundation map from 1998 Dhaka floods omitting Kamrangichar. (Mohit and Akhter 2000)

After the last major river flood in the area in 2004, the government undertook the construction of a "badh," a small embankment, to harden the riverfront edges of a portion of the char. While some residents credit the badh with reducing river flooding, others blame the new infrastructure for increasing waterlogging, a problem which residents report now plagues many areas of Kamrangichar on a regular basis during the annual monsoon. Residents of the unembanked northern portion of the char report that drainage in the area is better than in the embanked areas both on the char and within Dhaka's main embankments. Kamrangichar was long been excluded from Dhaka's political institutions and infrastructural protections. While residents recently successfully advocated for more political and infrastructural inclusion, the area continues to be plagued by negative impacts from infrastructures because new embankments have not been paired with necessary drainage infrastructure or land use and building regulation.

The land use plans created after the construction of Dhaka's western embankment called for development restrictions that would have reinforced the distinction between inside and outside zones. Much of the land between the embankments and the rivers were designated as "flood flow zones" off limits to urban development. However, as was the case with development restrictions for stormwater retention zones inside the embankments, these prohibitions have been largely unenforced. In the fifteen years between the release of the DMDP Structure Plan and the Detailed Area Plans (DAP) meant to elaborate the structure plan, many areas initially designated for flood-mitigation development restriction were urbanized. Against the protestations of activists in the local environmental and planning communities, the DAP largely accepted these incursions and simply changed the designation of large areas of land from flood flow zones and retention ponds to "urban residential" and "agricultural and rural homestead" (Sabet and Tazreen 2015; Bangladesh Institute of Planners 2008; Morshed 2013). The area directly upstream from Kamrangichar is a particularly dramatic example of this sort of illegal filling in flood flow zones. The land between the Rayer Bazar area near the embankment and the riverside village of Boshilla was once nearly all seasonally flooded agricultural land. After the embankment was

built and the levee-top road provided improved access, urban settlements spread rapidly through large-scale filling operations in the area (Figure 4.18).

Figure 4.18. Dhaka's western embankment as a spine of urbanization.

Subsequent planning processes after the DMDP have largely accepted illegal development as a *fait accompli* and simply changed land use maps to match the built reality. As one water sector planner told me, once urbanization has overrun flood mitigation zones, "now you have no option but to accommodate these changes. This is normally how our planning works" (S. Alam 2017). In Kamrangichar and the other areas excluded from Dhaka's western embankment, the infrastructures have shaped urbanization, not by altering hydrological conditions to make the land more amenable to urbanization, but by creating a spine for urbanization and improved access.

Mastan Urbanism: Infrastructural inaction enables informality from above

Landfilling plays an increasingly central role in Dhaka's contemporary urbanization and the production of uneven vulnerability in the city. As described above, there has been widespread illegal filling of ponds, khals, and retention areas within the western embankment. Landfilling is an even more central component of the urbanization of eastern Dhaka in the area outside of the city's embankments. Though the FAP 8a master plan and several subsequent projects have proposed expanding the city's levees to encircle the area between the current embanked zone of western Dhaka and the Shitalakya River to the east, the project has never been realized (Figure 4.19). In the absence of state flood protection infrastructure, private land developers have undertaken massive landfilling to enable the development of residential estates. These developers deposit enormous quantities of river sand onto former seasonal wetlands to create residential plots. While this landfill-based urbanization process avoids some of the pitfalls of embankment-based urbanization (e.g., waterlogging and the threat of catastrophic failure), this model too produces serious problems, including highly uneven patterns of vulnerability.

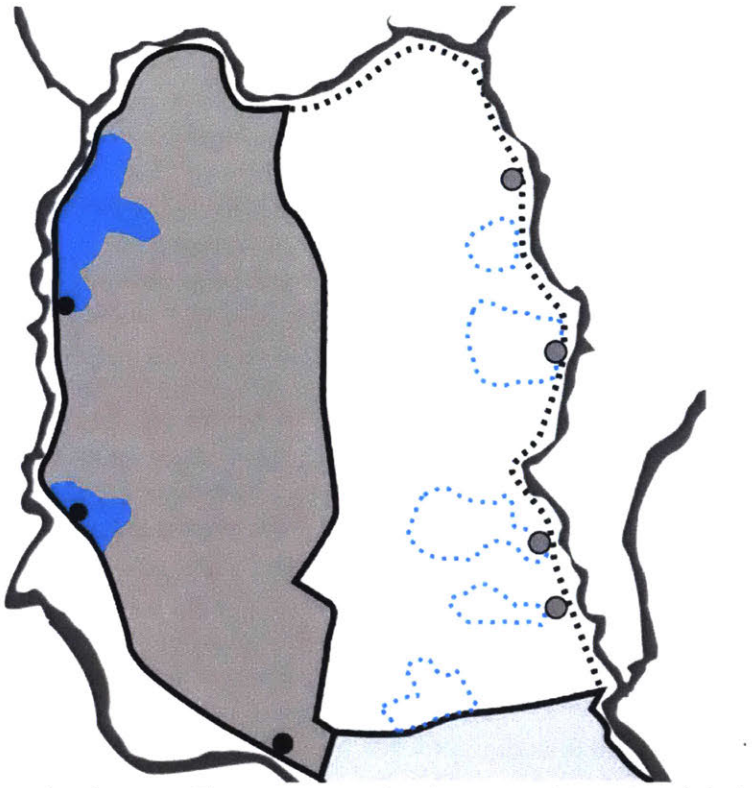

Figure 4.19. Dhaka's FAP embankments. The western embankment and associated drainage infrastructure were built in the early 1990s while the eastern embankment has been proposed on several occasions, but has not been built.

When Dhaka's western embankments were built in the early 1990s, Pragati Sarani, a major north-south thoroughfare that forms a central north-south meridian of the city, was elevated to form the eastern edge of the western embanked zone. The area to the east of Pragati Sarani had long been considered unfit for urban development. With its seasonal inundation from the overflowing waters of the Shitalakya River, the area was home to peri-urban villages clustered on islands of relatively high ground, surrounded by areas used seasonally for fishing, farming, and grazing. In the 1990s, as Dhaka's population continued to boom, development pressure on existing urban areas increased, speculation in urban land surged, and private companies started developing large swaths of the area in what is widely called the "eastern fringe" for residential development. A handful of powerful private land developers have developed thousands of hectares of former agricultural and village lands in eastern Dhaka in the last 25 years (Feldman and Geisler 2012; Sabet and Tazreen 2015). The Bashundhara Housing Area alone produced some 30,000 plots of land for private housing by filling more than 1,500 hectares (Rashid 2017).

To transform the eastern Dhaka landscape of seasonally inundated canals and paddy fields into expansive grids of residential development plots, land developers in eastern Dhaka transport and place massive quantities of river sand. A steady stream of barges laden with sand make their way from the Meghna River through a network of canals to pump sand and water through miles of steel pipe onto the once fertile and productive landscape. Barge by barge, the ground is elevated between 3 and 12 meters

to achieve a flood-safe (or at least saleable) elevation. The filled land produces enormous profits for developers as individual residential lots sell for up to $190,000[4] (Rashid 2017).

Some of Bangladesh's largest corporations are responsible for these eastern Dhaka land development projects. The Bashundhara Group, the group behind the area's largest development, is a private corporation involved in businesses from paper manufacturing, to cement, to shopping mall development. By some accounts Ahmed Akter Sobhan, the founder of The Bashundhara Group, is among the wealthiest people in Bangladesh. Neptune Land Development, the company responsible for a parallel massive land development project to the south of the Bashundhara Residential Area, is a subsidiary of the United Group which is involved in businesses from private hospitals and universities to textiles and ports. The mode of urbanization taking shape in unembanked eastern Dhaka is especially conducive to the involvement of these large and powerful corporations because developers must be able to mobilize enormous financial resources to fund private fleets of dredges, barges, and earthmovers. Perhaps just as importantly, they must be able to mobilize social and political power to influence both state actors and the existing residents of these peri-urban landscapes. In interviews, officials from government agencies and the World Bank referred to these land developers as "mafias" and "a government within the government." Residents of holdout villages adjacent to areas of active landfilling report threats and actual violence against both property and people at the hands of "mastan" or strongmen employed by the land developers and their allies in local government. As a former World Bank official told me, the land developers "are more powerful than the government" and people who resist the tide of landfill based urbanization in eastern Dhaka "will end up on the bottom of the Buriganga [River]."

Though this large-scale landfill-based urbanization is proceeding without the collective flood protection provided by an embankment, several influential actors in Dhaka have revived proposals to levee the area. A recent internal World Bank document advocating for the eastern embankment project reflects a recognition of the growing power of private land developers, arguing that the project "would save developers approximately US$1.5 billion in sand-filling costs" (World Bank 2015). The logic of these proposals rests on the idea that developers would prefer to have state-sponsored collective flood protection because it would simplify the development process, reduce developer costs, and raise the value of their land. However, this formulation fundamentally misunderstands the relationship between hydrology and real estate in the area. The absence of flood protection actually facilitates the current model of large-scale landfill-based development in at least four distinct but related ways. First and most pragmatically, the hydrological connectivity between eastern Dhaka's khals and the surrounding rivers enable barges to bring material close to fill sites, reducing piping and pumping costs. Second, because the area is still subject to regular inundation, without significant investment in landfilling, land prices are relatively low. While land prices of 'unimproved' land in the area are low, the process of filling land to convert it for urban development is very capital-intensive. The combination of low land prices and highly capital-intensive landfilling process means that only large, well-capitalized companies can afford to operate in this market. For actors with the capital and political power to undertake these projects, there are enormous profits to be made.

In addition to facilitating barge access and keeping the price of unfilled land low, the absence of embankments in eastern Dhaka also allows land developers to use the seasonal flux of floodwaters to undermine the livelihood viability of adjacent residents. Because much of the landfilling is undertaken

[4] According to representatives of a development company, lots in the area sell for between $24,000 and $190,000 per 5 katha (1/12th acre) lot, depending on their proximity to main thoroughfares.

during the rainy season when waters from the surrounding rivers inundate the unfilled land in eastern Dhaka, the slurry of river sand that developers use to fill the land overflows onto adjacent farmland ruining the fertility for both agriculture and wild fisheries. Land developers often build barbed wire topped walls of reinforced concrete and brick around parcels of eastern Dhaka lands to stake their claims. However, they tend to leave the bottom of the wall elevated several feet above the pre-filled grade, allowing pumped sand to flow under the walls and onto adjacent lands (Figure 4.20).

Figure 4.20. Enclosure walls deployed by private land developers in eastern Dhaka. By leaving the bottom of the walls open, developers allow the sand slurry used to elevate their land to spill onto adjacent land and waters, rendering them unfit to provide the fishing and farming livelihoods on which residents of peri-urban areas rely.

One long-time eastern Dhaka resident complained that this strategy can ruin fifty units of adjacent land for every unit that is actually filled. Once the existing agriculture and fisheries livelihoods of area residents are destroyed, developers can more easily force peri-urban residents to sell. According to a 2006 Halcrow proposal for an eastern embankment, "developers are grabbing khas [officially unclaimed] lands, that is the khals as well as the land belonging to socially weak and vulnerable communities. The latter are forced to sell their land at very low prices" (Halcrow Group Limited 2006).

Finally, the continued lack of the eastern bypass and embankment has meant that much of the eastern part of the city is inaccessible and invisible to most Dhaka residents and government officials. In conversation and in planning documents, the area, which accounts for a large percentage of the land area of the city, is simply referred to as "the eastern fringe." RAJUK and other state and institutional development interests have remained remarkably uninvolved in the development of this part of the city, providing only the sparsest of visions in land use plans. Out of sight of most Dhaka residents and largely out of the view of the planning and regulatory agencies, developers have been able to pursue a model of highly profitable, but enormously environmentally and socially destructive *mastan* or strongman urbanism.

Though the current model of landfill-based urbanization relies on the maintenance of hydrological continuity between eastern Dhaka and the surrounding rivers, officials from land development companies and government agencies (RAJUK and BWDB) reported that developers were generally in favor of the construction of the eastern embankment project. Because of their investment in landfilling, the primary value that developers see in a new embankment is not in flood hazard mitigation, but in

providing greater road access to their residential developments through new levee-top roadways. According to one senior planner at RAJUK, land developers "don't care about the embankments. They want new roads to access the land and help raise their land values" (Chaudhury 2017).

While private land developers dominate urbanization in much of eastern Dhaka, state entities have been central to the development of more peripheral areas beyond the Balu and Shitalakya rivers to the east. The city's primary planning and spatial governance institution, RAJUK, and the Bangladesh Army are both active in land development in these outer areas. Though much of the area is flood prone and was identified as "flood flow zone" off limits from development in previous land use plans, these government entities are spearheading large-scale urban development in the area.

RAJUK's major project, Purbachal New Town sits just across the Balu River to the northeast of Bashundhara Residential Area. At nearly 2,500 hectares, the mixed-use project is the largest planned development in Bangladesh. It will eventually include some 26,000 residential plots and 62,000 apartments. The Purbachal development has moved ahead despite opposition expressed in RAJUK's own land use plans. In the 1995 DMDP Structure Plan, the planning consultants explicitly rejected RAJUK's strategy of developing "new satellite and high standard model settlements in remote and isolated locations" (RAJUK 1995). The authors argued that such policies "would be diverting scarce public resources from urgent priorities that need to be addressed in Dhaka" and they stated in clear terms that the plan "does not support or endorse the polices."

Though the Purbachal development is led by a government agency, it is well known that the development process has included widespread violations of development regulations and rampant corruption. A major portion of the development plots in Purbachal have been set aside for current government officials, from parliament members and judges to military officers (Sabet and Tazreen 2015). Though some of Purbachal's land is relatively high and flood-safe, other areas are flood-prone and required filling for development. However, RAJUK did not secure the necessary clearance from the Department of Environment to conduct this massive illegal filling (Sabet and Tazreen 2015). One RAJUK official complained that RAJUK itself "showed the way" for other illegal development when they repeatedly broke planning, building, and environmental rules in developing Purbachal. This frustrated official asked, "How will RAJUK take a strong stand after RAJUK had already violated their own plan?"

One of the projects that has followed the example set by Purbachal is the Jolshiri Aboshon new town development just downriver on the Balu River. Jolshiri is a nearly 850-hectare area directly east of the Bashundhara Residential Area. According to the project website, Jolshiri, which commenced in 2009, will be a "comprehensive modern township development" with an eventual population of one million residents, complete with commercial and residential developments, wide streets, and a stadium complex ("About" 2017). The new town is envisioned as simultaneously connected to central Dhaka and as a place apart from the city's problems, "a well-planned, eco-friendly, self-reliant residential township" ("About" 2017). According to the project website, Jolshiri is an "Army Officers Housing Project" whose Board of Directors is "drawn from the top brass of Bangladesh Army and headed by a Chairman in the rank of Major General" ("About" 2017). As is the case with the military-led Defense Officers Housing Society (DOHS) residential development projects in Dhaka, the project is not intended to house solely military personnel. Rather, the plots are allocated to officers as part of their compensation with the assumption that they will be sold or developed for profit. Though the project website claims that Jolshiri was "planned to blend human habitats with earth and its pristine environment," the entire development will be built on landfill in an area that was designated as a "flood flow zone" in the DMDP.

As in the private landfill developments in eastern Dhaka, the threat and mobilization of violence has been central to the process of Jolshiri's development. In interviews, officials from BWDB, RAJUK, and other government agencies complained that the Army was able to flagrantly break land development rules because of their political power and ability to mobilize violence. In the words of one former RAJUK official who has worked on the new 2016 Structure Plan for the city, "the army filled up the land" and RAJUK was forced to "accommodate it in the plan... because they have guns, you know!" According to one newspaper account, the Army "did not even approach RAJUK for consultation, let alone seeking RAJUK's approval" ("Project Area Includes Flood Flow Zone" 2010). The project website claims that, "Important aspects of the project is [sic] that, no village or dwellings are included inside the project. Barren low lands are chosen for the project" ("About" 2017). However, interviews with knowledgeable government officials and local newspaper reports indicate that the Army was only able to undertake its ambitious new town project by violently displacing existing communities. According to accounts of residents reported in a local newspaper, in 2010 "locals broke into fierce protests against the 'forced purchase of land' by army officers" and at least one local villager was killed and several others injured in the "pitched battles" between villagers and law enforcement and military personnel that followed ("They Just Disappear" 2010).

Recent development patterns in eastern Dhaka challenge conventional binary conceptions of public and private action with respect to flood mitigation and development. The development patterns of Jolshiri and Purbachal, as in the Bashundhara Residential Area and other private developments in eastern Dhaka, rely on illegal landfilling to privatize flood mitigation. The developments disregard existing land use plans and development rules and employ strong-arm tactics to displace existing settlements. Though RAJUK and the Army are both nominally state actors, these projects operate with the same ruthless entrepreneurial profit-maximizing logic as private developments. Because of their links to centers of state-power, these public agents of mastan urbanism are able to at least partially legitimize their violence and patronage through such strategies as allocating plots strategically to help secure political support. Collectively, the private and public mastan urbanism of eastern Dhaka demonstrates how strategic inaction in the realms of infrastructure (e.g., not building structural flood protections) and planning can shape uneven urbanization and vulnerability. These patterns resonate with what Roy labels "informality from above" (A. Roy 2009).

The landfill-based mastan urbanism that has emerged out of these patterns of elite informality in eastern Dhaka avoids some of the critical problems of levee-enabled urbanization, but it has its own set of problematic outcomes. Compared to levee and pump based urban expansion in both Dhaka and New Orleans, landfill-based urbanization is less reliant on on-going technical operations and maintenance. These areas are less vulnerable to the problems of broken pumps and catastrophic failures of structural flood protections. Without levees, there is no levee effect and no elevated risk to poorly adapted settlements. Levee planners in Dhaka have long complained of the difficulty of recovering the cost of their projects from the property owners who benefit from collective flood protection (Louis Berger International 1991). With landfill-based urbanization, cost recovery is relatively easy because the cost of land reclamation is simply incorporated into the sales price of land. The relative ease of cost recovery arises from the fact that landfill-based flood mitigation treats flood risk reduction as an excludable private good rather than a non-excludable public good as is the case with levee-based mitigation. Whereas a system of levees and pumps, at least in theory, provides consistent benefits to all of those within a levee-defined perimeter, landfill-based urbanization privatizes flood mitigation, benefiting only those who can afford to pay to purchase or rent newly elevated ground. In Dhaka, these large landfill urbanized areas are exclusively home to middle and upper-class urban residents. As discussed above, the uneven costs and benefits of landfill-based urbanization are radically skewed, providing enormous

speculative profits to developers and investors while displacing preexisting peri-urban communities through ecological destruction and violence.[5]

Dhaka's Embankments: Not Edges, but Spines of Urbanization

As was the case with New Orleans' post-Hurricane Betsy levees, Dhaka's levees have not had the effect on urbanization that the project's planners anticipated. When the more urbanized western portion of Dhaka was empoldered in the early 1990s, planners and levee boosters argued that the new infrastructure would structure and discipline the city's unruly growth. They anticipated that the new infrastructure would "encourage in-migration" to the newly "flood free zone" (Louis Berger International 1991). Subsequent land use plans incorporated levee-based land use distinctions, including "flood flow zones" (RAJUK 1995, 2016). An analysis of demographic trends of population and density growth in the wards that were inside and outside of the new embankments shows a different picture (Table 4.2). While planners expected that Dhaka's new embankments, like those in New Orleans, would serve as *edges* to urban development, the infrastructures have actually become *spines* of urbanization, from which urban development has proceeded rapidly, both inside and outside. This dynamic is readily discernable in demographic data, in observation of time series satellite imagery and in on-the-ground observation.

According to statistics from the Bangladesh Bureau of Statistics (BBS), the population of wards located inside the newly empoldered area did increase rapidly in the decade after the construction of the embankments. Between 1991 and 2001 the population of these "inside" wards increased by 55%. However, over the same period, the population of "outside" wards increased even more at 63%. In the decade between 2001 and 2010, after the completion of the bypass road atop the embankment, the "split" wards, those through which the embankments pass, grew faster in both population (61%) and density (32%) than either "inside" wards (20% population growth and 15% density growth) or "outside" (13% population growth and 9% density growth) (Table 4.2). Satellite photographs from 2001 to 2014 (Figure 4.18) and field observations in 2014-2017 suggest that there has been a dramatic increase in urbanization in the territory outside of Dhaka's western embankments, contradicting the expectation of a massive in-migration by people seeking flood security.

Table 4.2. Dhaka's Embankments and Population and Density Growth

	Wards	Population Growth '91-'01	Population Growth '01-'11	Density Growth '91-'01	Density Growth '01-'11
Overall	120	56%	27%	41%	16%
Inside	62	55%	20%	44%	15%
Split	24	49%	61%	35%	32%
Outside	34	63%	13%	40%	9%

As in New Orleans, Dhaka's embankments have not structured urban growth to the extent that planners anticipated. Where growth in the areas outside of New Orleans' levees was driven by broader patterns of suburbanization, increased road and bridge infrastructure, and race-based demographic shifts ("white flight"), Dhaka's levees have directly contributed to growth in outlying areas by increasing access to previously inaccessible low-lying areas. While levee planners anticipated that the levee-top road would

[5] Recent studies have suggested that the landfill based urbanization of eastern Dhaka may also exacerbate seismic risk as the area's underlying soils are particularly prone to liquefaction (RAJUK 2016).

contribute to the "future expansion" of the Dhaka metropolitan area, there is no evidence that they expected that this growth would be so difficult to control (Louis Berger International 1991).

While Dhaka's embankments have not structured urbanization in the ways that project planners anticipated, they have nonetheless become drivers of uneven urbanization and vulnerability. As in New Orleans, the ways that Dhaka's dry city infrastructures have shaped urbanization are driven by the place-specific, historically contingent path-dependent dynamics that they have created as they have become enmeshed into socio-technical levee complexes. These complexes include other infrastructural components (e.g., levee-top roads) as well as formal and informal mechanisms for spatial governance (e.g., unenforced land use and building regulations). The confluence of rapid population growth, the financialization of urban land, and limited economic resources and low spatial governance capacity of state institutions have led to urbanization conditions in Dhaka in which levees play a very different role than they do in New Orleans.

	Dominant Spatial Function	**Mediating Socio-Technical Factors**
New Orleans	**Edge**	**OTHER INFRASTRUCTURE** - Mechanical drainage - Roads and bridges
		SPATIAL GOVERNANCE - Land use and building regulations aligned & enforced - Wetland protections - Subsidized flood insurance
		BROADER SOCIO-SPACIAL POLITICS - Racial politics - Anti-adaptive bias - Inter-jurisdictional competition
Dhaka	**Spine**	**OTHER INFRASTRUCTURE** - Ineffective pumping and drainage - Levee *as* road
		SPATIAL GOVERNANCE - Land use and building regulations not enforced; - Weak/uneven property regimes (e.g., 'elite informality')
		BROADER SOCIO-SPATIAL POLITICS - Extreme land & population pressure

Table 4.3. Levee Complexes in Dhaka and New Orleans

Conclusions

The two previous chapters traced the process by which Dhaka and New Orleans each came to embrace substantially similar dry city infrastructural modernization infrastructures. Though the founding of the two cities were separated by one hundred years and nearly nine thousand miles, they share important characteristics with respect to their geophysical situation in low-lying landscapes near the mouth of great continental river deltas and their founding missions as outposts for colonial military and

commercial interests. While each city faced radically different demographic, governance, and political challenges, by the end of the 20th century, they had both developed systems of structural flood protection and mechanical drainage to manage water in the name of protecting people and property and enabling structured urban growth.

This chapter has presented miniature case studies of six different settlement areas, three in Dhaka and three in New Orleans, which together demonstrate the variegated and heterogeneous ways in which levees and other associated infrastructures have shaped urbanization both within and between the two cities. Collectively, these brief accounts make the case that it is not levees that shape urbanization so much as it is the dynamic socio-technical networks within which levees are embedded. These levee complexes include not only levees and associated drainage and flood control infrastructure, but also formal and informal institutions, from planning and building regulations and insurance programs to changing social perceptions of risk and biases regarding architectural style that can either support or dampen individual adaptive choices. While the design and configuration of levees themselves do play an important role in shaping uneven vulnerability, it is the character and dynamics of these levee complexes that are responsible each city's unique patterns of uneven urbanization and vulnerability.

Given the complexity and dynamism of levee complexes, it is perhaps not surprising that simple models that ascribe stable and unified causes and responses to levees are limited in their explanatory power. In examining how levees shape urbanization and uneven vulnerability, basic structural and behavioral models are useful starting points, but they are inadequate and misleading without considerable amendment and enrichment. Structural models, including the growth machine (Logan and Molotch 1987) and simplified models of uneven vulnerability from human ecology (Hewitt 1983) and political ecology (Collins 2010) provide useful guides for understanding why cities build levees and how those levees might reinforce existing socio-economic inequalities. Behavioral models from the natural hazards school, like the concept of the 'levee effect' are likewise useful in making sense of how levees shape vulnerability by influencing risk perception and choice. The mini-cases in Dhaka and New Orleans make clear that, while these frameworks accurately characterize conditions in specific places at specific times, there is a need for considerably more dynamism and complexity in models to explain how levees produce uneven vulnerability and thus, how they will shape future urban adaptation. While the same model of dry city infrastructural modernization took root in both Dhaka and New Orleans over the course of the 20th century, these cases show that the mechanisms by which these infrastructures produce uneven vulnerability is highly place-specific, path-dependent, and historically contingent.

The growth machine hypothesis positions levees as a means of enabling a particular model of urban growth and private accumulation favored by stable and unified local public-private growth coalitions. This conceptualization of levees does align with conditions in both Dhaka and New Orleans at particular times. In New Orleans, the growth machine provides a reasonably accurate accounting for the early 20th century mobilization of civic and commercial elites and their new hydrocracy institutions to drive modernization and suburban growth through dry city infrastructures of levees and pumps. Likewise, the recent appeal by levee-boosters that an eastern embankment in Dhaka would facilitate private land development in the area also positions levees as powerful tools for environmental transformation in the hands of public-private growth coalitions.

However, these instances of clear levee-driven growth machine dynamics represent exceptions rather than a normal state of affairs. In both cities, water infrastructure planning and local spatial planning have long been characterized by fragmentation, opposition, and competition rather than by unity and coordination. The interests of public and private sector actors in dry city infrastructures have long been

fragmented both geographically (e.g., inter-jurisdictional competition for growth and resources) and sectorally, with some institutions and interest groups favoring levee-and-pump based urban growth and others opposed. In New Orleans, the growth machine dreams of eastern New Orleans levee boosters were largely scuttled by competition from other suburban parishes with their own growth aspirations. In both cities, levees have long been linked as much to national institutions and priorities as to local ones. In the case of Dhaka, international institutions have played a pivotal role in both supporting and opposing the adoption of dry city infrastructures. When levees were planned and built in Dhaka, they were promoted more as a means of controlling and disciplining growth rather than promoting it. The case of landfill based mastan urbanization in the unleveed area of eastern Dhaka, also makes clear that infrastructural *inaction* and a lack of regulatory enforcement can facilitate growth.

In both cases, levees have not structured urban growth in the ways that project boosters had hoped. Over recent decades, both Dhaka and New Orleans have seen a shift away from collective flood mitigation measures like levees and towards more individual and privatized forms of mitigation, such as landfilling. This infrastructural transition matches the model of "splintering urbanism" described by Graham and Marvin (S. Graham and Marvin 2001) wherein 'comprehensive' infrastructures give way to uneven and privatized infrastructures. Thus, while boosters have long promoted levee projects as a means of encouraging and guiding growth, the evidence from Dhaka and New Orleans indicate that the relationship between levees and growth is complex, dynamic, and uneven. As with other forms of public infrastructure, flood mitigation has become even more uneven with the broader pattern of state retrenchment of the late 20th century. However, as the next chapter will explain, contemporary efforts at urban climate adaptation infrastructure suggest a revival of large scale, state-initiated, flood mitigation infrastructure projects.

In making sense of how levees shape uneven vulnerability, models of the production of vulnerability from human ecology (Hewitt 1983; Wisner et al. 2004) suggest that the design, construction, and performance of infrastructure reinforce existing socio-economic disparities in society, exposing disadvantaged groups to disproportionate risk. Collins' model for the political ecology of environmental risk similarly indicates that levees and their associated infrastructures and institutions are a means of facilitating favored groups to live in environmentally risky places and marginalizing less-favored groups in ways that expose them to greater risk (Collins 2010). Again, the micro-cases described here indicate that these dynamics of structural production of vulnerability are at play in particular places and times. The early history of the Batture settlement and the exclusion of Kamrangichar from Dhaka's western embankment are both clear instances of marginalization of poor and disempowered groups into positions of heightened vulnerability outside of levees. Levee-based suburban development in both cities and subsidized flood insurance in New Orleans are also clear instances of facilitation of more favored groups.

While it is clear from the cases that groups with more political and economic resources tend to benefit disproportionately from both state action and inaction related to urban flood mitigation, the particular patterns of uneven vulnerability are considerably more complex than a simple model of facilitation and marginalization would suggest. As with the insufficiency of the growth machine model, these models of simplified structural vulnerability production also require further amendment based on the cases. The cases again make clear that the character and interests of all of the presumed categories of actors – state and non-state actors, politically favored and disfavored groups – must be regarded not as unified and stable, but as dynamic, fragmented, and interwoven in complex relationships of competition and cooperation. Different state policies or actors may simultaneously facilitate and marginalize a given population or area as demonstrated in the case of the prosperous and white Venetian Isles' residents

who enjoy subsidized flood insurance, but also regard themselves as marginalized by infrastructural planning decisions that left them exposed to mounting flood risk. Similarly, a given area or group may shift unexpectedly from facilitation to marginalization or vice versa. For instance, the relative prosperity and political power of today's Batture residents make it difficult to claim that they, like their predecessors, were exposed to heighten flood risk because of marginalization.

Much as rigid and simplified structural models are insufficient for making sense of the relationship between dry city infrastructures and uneven urbanization, behavioral models that focus on the role of individual risk perception and choice are also useful, but not sufficient to explain the production of uneven vulnerability in Dhaka and New Orleans. There are instances in the cases presented here that match the behavioral expectation that levees would lead to levee effects, wherein new infrastructures create a 'false sense of security' leading to risk blind building and development patterns and, eventually, to increased vulnerability in the event of infrastructural failures. The embrace of poorly adapted, non-elevated 'modern' building types in the levee-enabled eastern New Orleans suburbs clearly fits this pattern. However, this tidy model only holds explanatory power under very specific conditions and for discrete periods of time. In both Dhaka and New Orleans, problems with the performance of engineered flood protections have reduced or modified the incidence of the levee effect as residents have lost faith in dry city infrastructures. Persistent waterlogging problems caused by ineffective mechanical drainage inside Dhaka's embankments have motivated builders and residents to continue building elevated structures even after the levees have made elevation theoretically unnecessary. In both Dhaka and New Orleans, many residents of areas outside of levee protection reported feeling less vulnerable to flooding than nearby levee-protected areas given drainage problems within the polders and catastrophic failures like those witnessed during Hurricane Katrina.

While some 'outside' areas in both cities show signs of an 'inverse levee effect' where residents of non-protected areas adopt more household level adaptations, the embrace of unelevated construction types in areas outside of New Orleans' levees indicates that anti-adaptive biases and access to subsidized flood insurance also play important roles in shaping adaptation choices. Interviews in both Dhaka and New Orleans reinforced the importance of viewing flood vulnerability as just one among a suite of complex factors that people consider when determining where and how to live. Many residents choose to live with greater flood risk in exchange for other assets, including: access to jobs, transportation, and personal networks; improved safety with respect to crime or tenure security; and various landscape and lifestyle amenities. As with other simplified models for understanding the role of levees in shaping uneven urbanization and vulnerability, behavioral models like the levee effect must be modified and enriched with a more nuanced understanding of how levees become enmeshed in place-specific and historically-contingent levee complexes.

By exploring how levees have shaped urbanization and uneven vulnerability differently both within and between the two case study cities, this chapter highlights the limitations of simple causal models. The divergent urbanization pathways outlined here illustrate the naivety of expecting similar flood mitigation infrastructures to perform similarly across different urban settings. Over the course of the 20th century, boosters of dry city infrastructural modernization in both Dhaka and New Orleans advocated for projects on the theory that, through aggressive infrastructural interventions, public entities could reshape the relationship between land and water in predictable ways that would enable and guide urban growth. However, the geophysical, political, and social assumptions on which these projects were based have proven to be highly problematic. Uncooperative natural processes (e.g., subsidence, extreme events), uncooperative institutional processes (e.g., resource constraints, political resistance to regulatory enforcement), uncooperative political-economic processes (e.g., unexpected

demographic and macroeconomic changes), and an uncooperative populace (e.g., aesthetic preferences for certain landscapes or building styles) can all have profound impacts on the path-dependent processes of urbanization.

The simplistic assumptions of dry city infrastructure projects of the 20th century have created a range of unexpected urbanization dynamics and uneven vulnerabilities. These projects have also created path-dependent processes of urbanization that cannot be easily reversed or radically redirected. The next chapter will discuss the contemporary revival of interventionist state-led infrastructural modernization in both Dhaka and New Orleans.

PART III
The Design-Politics of Urban Flood Mitigation in the Age of Climate Adaptation

In the early years of the 21st century, city leaders in Dhaka and New Orleans, as in other similarly situated cities, faced something of a crisis. The flood defenses that they had relied on for generations were failing. Just as the scientific consensus coalesced in predicting dire climate change related flooding in many low-lying coastal and river delta landscapes, the levees and pumps that both cities had built over the course of the 20th century, were increasingly recognized to have created a range of problems. In the view of critics, these dry city infrastructures had proven to be both unwise and unjust. They are unwise in that their heavy-handed interventions in dynamic delta landscapes created unexpected social and ecological problems, from subsidence and coastal land loss to waterlogging and the threat of catastrophic failures. They are unjust in that the costs and benefits of these infrastructures were distributed radically unevenly, frequently exacerbating existing socio-economic inequalities. In New Orleans, the problematic nature of the city's dry city infrastructure and the urban patterns that it had enabled was laid bare when the levees and pumps failed during Hurricane Katrina in 2005. In Dhaka, though the city's levees and pumps have only been in place since the early 1990s, they were already proving to be deeply problematic by the close of the 20th century. Rather than confining and guiding urban growth as promised by their planners, Dhaka's levees had become spines of urbanization both inside and outside of the zones of protection. While Dhaka grew dramatically in both population and territorial extent, the city's lack of financial resources and spatial governance capacity meant that infrastructure could not keep up, leading to regular waterlogging within the levees and sprawling landfill-based development outside the protected zone.

Dhaka and New Orleans each followed distinctly different paths to develop their 20th century dry city infrastructures (see Chapters 2 and 3). Through the unfolding of urbanization processes, their levees became embedded in dramatically different socio-technical networks or levee complexes (see Chapter 4). As such, the nature of their 21st century flood infrastructure challenges are very different. Nonetheless, as each city confronts the uncertainties of climate change and uneven urbanization and as each grapples with the legacy of inherited infrastructures, they share some important commonalities.

The next two chapters assess the changing politics of contemporary urban flood mitigation in Dhaka and New Orleans. With the growing influence of Dutch water expertise in flood vulnerable cities around the world, design and spatial planning have taken on an increasingly central role in flood mitigation planning. These chapters focus particular attention on how design is shaping the politics of urban flood mitigation in Dhaka and New Orleans. This "design-politics" approach considers how design processes, visualizations, and realized projects both reflect and shape changing social meaning and power relations (Vale 2013).

Chapter 5 explores the extent to which these new Dutch-influenced flood mitigation projects are and are not delivering a new paradigm for 'living with water.' Chapter 6 focuses particular attention on the role of design tools and methods in both improving urban flood mitigation and reducing the space for dissent and political deliberation.

CHAPTER 5
The Return of Flood Infrastructure Mega-Projects in the Era of Climate Adaptation

Chapter Summary

The later decades of the 20th century saw increased skepticism of ambitious state-funded flood infrastructure mega-projects in Dhaka and New Orleans. Along with broader shifts towards neoliberal privatization and away from interventionist state-led growth, critiques mounted against the levee and pump based urban growth model of previous generations. In recent years, there has been a resurgence of interest in interventionist state-led water management infrastructure projects in both cities. Advocates of these flood mega-projects invoke a number of justifications, including: changes in climate and landscapes; rapid urbanization; and recent dramatic urban flooding events (e.g., Hurricanes Katrina, Sandy, and Harvey, tsunamis and cyclones).

While many contemporary flood infrastructure proposals rival or surpass the scale and ambition of the largest projects of the mid-20th century golden age of infrastructural modernization, advocates insist that these projects are qualitatively different from the discredited models of the past. This new generation of projects is often pitched as 'resilient', 'adaptive', and 'ecosystem-based'. Many contemporary flood planning programs embrace agreeable slogans such as 'design with nature', 'living with water', and 'room for the river.' Many build off of recent water management practices in the Netherlands. Public and private networks promote Dutch water expertise as a new 'export commodity' for the climate change era. Ambitious Dutch-led water planning and infrastructure efforts are underway in cities around the world, including in New Orleans and Dhaka.

This chapter analyzes several recent and ongoing flood planning proposals in Dhaka and New Orleans which exemplify this new generation of projects. Through analysis of proposal documents and interviews with project participants, observers, and critics, the chapter addresses the questions: To what extent are these new projects advancing a new paradigm of urban water management and to what extent are they recreating the problematic patterns of previous generations? The chapter pays particular attention to ambitious Dutch-influenced projects, including the Bangladesh Delta Plan 2100 and the Changing Course competition for the lower Mississippi Delta.

Recent experience in Dhaka and New Orleans suggests that, while many new flood mitigation projects may widen the scope of knowledge brought to bear and address some of the problematic patterns of past mega-projects, many concerns persist. The cases of Dhaka and New Orleans have shown that (1) once in place, dry city infrastructures are highly obdurate or resistant to change because they become embedded in dense socio-technical networks or levee complexes; (2) despite the promising rhetoric of a 'new paradigm' in urban water management, conventional dry city infrastructure projects continue to proliferate because of path-dependent patterns rooted in entrenched simplifying epistemologies and material interests with 'big engineering' biases; and (3) even projects and strategies that do depart substantially from the levee-and-pump mega-projects of the past continue these same path-dependent dynamics and threaten to reproduce many of their worst impacts. These projects exemplify a new generation of 'eco-infrastructural modernization,' which, like previous generations' of projects, promise wholesale social and economic transformation through investment in physical infrastructure. The evidence from Dhaka and New Orleans suggests that rather than ushering in a new era of city-nature harmony, these projects may reproduce the same patterns of unwise and unjust development created by the mega-projects whose damages they were supposed to repair.

Introduction: The Fall and Rise of Urban Flood Infrastructure Mega-Projects

Recent years have seen a resurgence in ambitious state-led urban stormwater and flood management infrastructure projects, frequently framed as addressing the failings of previous generations of dry city infrastructure while responding to the emerging crises of climate change and uneven urbanization. Though these renewed state efforts often signal that they are part of a new paradigm of urban water management, they repeatedly revive old strategies and projects. Many of these projects use the rhetoric of adaptive, resilient, and ecosystem-based approaches to promote projects that are thinly rebranded efforts at dry city infrastructural modernization. Finally, when recent and ongoing projects have genuinely advanced new strategies that address the failings of dry city infrastructural modernization, they often lead to highly uneven distributions of costs and benefits, exacerbating existing urban inequalities. Whether promoting dry city visions or advancing new more open strategies, these projects are too often premised on a model of infrastructural modernization that promises to remake the social, political, and economic life of cities through investments in physical infrastructure. As in previous generations of infrastructural modernization, these recent and ongoing projects emphasize readily quantifiable geophysical processes, enabling the transfer of expertise, strategies, and technologies between similar landscape settings and they too often under appreciate the path-dependent, place-specific, and historically contingent processes that impact how infrastructures shape uneven urbanization and vulnerability.

Critiques of Dry City Infrastructural Modernization as Unwise and Unjust

As discussed in previous chapters, Dhaka and New Orleans each followed distinct paths towards dry city infrastructural modernization over the course of the 20th century. While New Orleans has long been utterly reliant on hardened flood protections and mechanical drainage for protection and expansion, for most of Dhaka's nearly 400 years of urban settlement, the city did not have substantial structural flood protections or mechanical drainage. Interventionist water resources management on the lower Mississippi and levee-led growth in metropolitan New Orleans were characteristic of a 20th century model of state-led infrastructural modernization. This approach was explicitly recognized as a model when leaders in East Pakistan (later Bangladesh) embraced plans for infrastructural modernization of the eastern Bengal delta. These efforts were led during the post-World War II era by "Ambassadors with Bulldozers" from the public and private sectors in the USA. They first aimed to use infrastructure investments to harness delta rivers for electrification, irrigation, and industrialization. By the 1970s, urban development had become another venue for water infrastructural modernization. After consecutive years of heavy flooding in the capital in the late 1980s, the ruling military regime built Dhaka's first 'cordon' embankments and pumps as part of the larger internationally funded Flood Action Plan (FAP).

By the close of the 20th century, earthen embankments and floodwalls substantially surrounded urban settlements in both Dhaka and New Orleans. With these new structural barriers in place, both cities were largely reliant on mechanical pumps for stormwater drainage. Levee boosters in both cities made the case that dry city infrastructures would enable orderly growth and address urban challenges from race-based suburbanization in New Orleans to chaotic development and insufficient transportation infrastructure in Dhaka. While advocates, experts, and residents in both cities had, since the mid-20th century, debated alternative non-levee and pump based approaches to water management, levee boosters capitalized on post-flood crisis mobilizations to advance their projects.

Numerous critiques of dry city infrastructural modernization emerged by the end of the 20th century. Criticism of levee and pump-based urbanism, like broader criticism of interventionist mega projects, can be broadly grouped into two categories: that these projects were *unwise* and that they were *unjust*.

Critiques of mega-projects as unwise center on the tendency for such project to under estimate costs and negative impacts and to over estimate benefits (Flyvbjerg, Bruzelius, and Rothengatter 2003). Serious risks of dry city mega projects have been well documented, including: interrupting existing ecological and hydrological landscape processes (Corthell 1897; Mukerjee 1938; Mahalanobis 1927; Iqbal 2010); creating so-called 'levee effects' which increase rather than decrease vulnerability by creating a false sense of security and encouraging unwise development practices (White, Kates, and Burton 2001); requiring long-term commitments to expensive operations and maintenance, a particularly problematic pattern in contexts with limited financial and technical resources. While some focused their criticism on the unwise nature of levees and other mega-projects, others were more concerned with the unjust impacts of these interventions in exacerbating existing socio-economic inequalities. In both the Mississippi and Bengal deltas, critics had long decried the uneven impacts of levee mega-projects that promote particular modes of land use and development benefiting already politically and economically empowered segments of society at the expense of weaker groups. For example, Adnan and others criticized the FAP levee and polder projects in Bangladesh (Hughes, Adnan, and Dalal-Clayton 1994; A. Rahman 1995) for devastating the lives and livelihoods of the urban and rural poor. Similarly, the uneven impacts of levee operations and failures in south Louisiana have been a common theme since at least the floods of 1927 (Barry 1997). For both groups of critics (unwise and unjust), the catastrophic damage, loss of life, and uneven recovery in New Orleans following the failures of the city's levees and pumps during Hurricane Katrina were an object lesson, clearly demonstrating that dry city infrastructures were unwise (Colten, Kates, and Laska 2008) and unjust (Squires and Hartman 2006; Gotham and Greenberg 2014).

These mounting critiques coincided with an increasing embrace of neoliberal governance in the late 20th century, which called for reduced state interventionism across a broad range of planning and policy domains. From the mid-century peak of "Promethean projects" of infrastructural modernization (Kaika 2004), new legal and regulatory tools enabled citizen resistance movements, restricting central government funding and constraining the power of local growth coalitions (Altshuler and Luberoff 2003). With this state retrenchment, Graham and Marvin traced a shift from "comprehensive" infrastructures of previous eras to a "splintering urbanism" of uneven and fragmented infrastructures (S. Graham and Marvin 2001). Changes in flood mitigation strategies in both Dhaka and New Orleans over the mid-to-late 20th century resonate with this broader transition; state-led collective mitigation faltered in the face of increasing criticism and state retrenchment. In place of collective levee protections, smaller scale, private, and market-based solutions were increasingly important. In Dhaka, public and private land developers have privatized flood mitigation in many areas outside of the city's levees through massive landfilling efforts that provide flood mitigation only for those who can afford to buy elevated land. These efforts exacerbated flood problems in less elevated areas, amplifying uneven flood vulnerabilities in the city. In New Orleans too, in the years since the last major levee expansion following Hurricane Betsy in 1965, the region has seen faster growth in areas outside of levee protection where people rely on a combination of household level adaptation (e.g., elevation) and subsidized flood insurance to mitigate their private risks.

The Revival of Urban Mega-Projects

While state-led mega-projects subsided in the late 20th century, the early decades of the 21st century have seen a reinvention of urban mega-projects across a range of types and scales. In response to critiques and legal restrictions, conventional mega-projects of previous eras have morphed to focus more on 'inducement' and 'enablement' of private market actors through public-private partnerships and other structures (Altshuler and Luberoff 2003). Urban mega-projects in Europe and North America now tend to be designed to minimize human displacement (Altshuler and Luberoff 2003), frequently

focusing on redevelopment of former industrial, waterfront, and land reclamation sites. Many of these new urban mega-projects at-least rhetorically emphasize environmental sensitivity and design-driven urbanism (Orueta and Fainstein 2008).

As with other types of urban mega-projects, ambitious urban flood mitigation projects have become more common in recent years. In response to the paired crises of climate change and uneven urbanization, many cities are planning new structural flood defenses. The post-Hurricane Sandy *Rebuild by Design* competitions, first in the New York City region and more recently in the San Francisco Bay Area, have proposed major structural and ecosystem-based flood mitigation schemes ("Rebuild By Design" n.d.). Massive "super-levees" in Tokyo, the proposed "Great Garuda" land reclamation scheme in Jakarta (Yarina 2018; Goh 2015), and the Eko-Atlantic reclamation project in Lagos (Watson 2013) all pair flood protection with ambitious urban real estate development projects, frequently targeted for high end development capitalizing on waterfront access and views. Manila, Ho Chi Minh City, and Bangkok also have major flood protection projects in the planning and construction phases. In spite of the serious problems that both Dhaka and New Orleans have experienced with previous generations of flood mega-projects (see Chapters 2,3, and 4), both of these cities are also weighing proposals for ambitious state-led flood infrastructures. It is these projects that are the focus of this chapter.

Dual Crisis Framing: Climate Change and Urban Change

While the motivation and problem framing for contemporary flood mitigation projects vary from case to case, many proposals share some common features. River delta and coastal cities around the world face increasing vulnerabilities to flooding with climate change (Hallegatte et al. 2013). Across a range of scales, project proposals in both New Orleans and Dhaka often reference climate change as a motivation for action. Both cities are vulnerable to increases in rain and river flooding along with heat waves (Hallegatte et al. 2013; Hanson et al. 2011; N. Smith 2006; Henderson 2017; Dasgupta et al. 2015). In the New Orleans region, climate change is also projected to increase vulnerability from sea level rise and coastal storms. These threats, compounded with land loss and subsidence, are frequently presented as existential threats to human settlements in the region. In a characteristic display of gallows humor, Mardi Gras festivities in 2018, the 300th anniversary of the founding of the city, included a paper-mache submarine floating past the city's central St. Louis Cathedral one hundred years in the future, submerged "20,000 Arpents Under the Sea." The descriptions of climate change threats in Dhaka and New Orleans use metaphors of crisis. In some cases, the metaphors invoke war; these cities are "battling" on the "front lines" of climate change (Henderson 2017). In other cases, they invoke epidemiological outbreak. A recent World Bank report describes Dhaka as "an urban hot spot for climate change" (Dasgupta et al. 2015). These crisis framings are essential to advocating for new flood infrastructure as part of an urgent response to an existential threat.

Mega-project advocates also tend to point towards shifting patterns of urbanization as a justification for renewed infrastructure investment. These drivers are frequently framed in terms of mismatches between infrastructural needs and capacities. In the case of Dhaka, advocates describe the city's rapid, largely-unplanned, and under-serviced urbanization as a crisis demanding urgent action, including major flood infrastructure investment (World Bank 2016). The city's poor residents are frequently cited as both drivers and victims of flood vulnerability. In Dhaka, as elsewhere in other fast growing south Asian cities (Ranganathan 2015), engineering reports blame "encroachers" in informal settlements along the city's canals for impeding the functioning of the drainage system (General Economics Division 2016). A recent World Bank report states that,

> The city's poorer inhabitants are usually among the most vulnerable since large, densely populated conglomerations of slums and shanties are located in areas of unplanned and unregulated development. (Dasgupta et al. 2015)

In New Orleans too, shifts in urban settlement figure prominently when flood infrastructure advocates make their case for new projects. The city's *Resilient New Orleans Strategy* blames the 20th century patterns of dry city infrastructural modernization for producing the city's vulnerability. The strategy says that, with these 20th century urbanization shifts, New Orleans "abandoned our long history of living with water" and set "the stage for challenges to our water management and flood protection systems" (City of New Orleans 2015). In both cities, advocates of infrastructure investment point towards dual crises in making their case: climate change has compounded the crisis of mismatched urbanization and infrastructure planning.

A New Generation of Urban Water Management Projects

Driven by this dual crisis framing, advocates in both Dhaka and New Orleans are developing ambitious plans for new state-led flood mitigation. Some of the key projects are described in brief below. In both cities recent and ongoing urban flood mitigation planning can be broken into three broad types. First, both cities are embracing a renewed focus on *fortification*, actively hardening their urban edges through investment in conventional dry city infrastructures such as levees, floodwalls, and pumps. Second, leaders in both cities are pursuing strategies of *internal softening*, using "green infrastructure" landscape-based strategies to increase stormwater retention capacity inside their hardened perimeters. Finally, large-scale planning exercises promise *regional restructuring* of the relationship between land and water beyond the conventional urban boundaries of both cities. Table 5.1 includes some prominent projects in each of these types.

	Fortification	**Internal Softening**	**Regional Restructuring**
New Orleans	Post-Katrina "Hurricane & Storm Damage Risk Reduction System"	Greater New Orleans Water Plan Gentilly Resilience District	Changing Course; Coastal Master Plan
Dhaka	Eastern embankment; Western Dhaka supplemental pumping.	Hatirjheel; Water Urbanism.	Bangladesh Delta Plan 2100

Table 5.1. A typology of contemporary flood mitigation projects in Dhaka and New Orleans.

The following section briefly describes several key recent and ongoing projects in Dhaka and New Orleans that will be discussed in greater depth in later sections.

Fortification

New Orleans

Since the levee failures of Hurricane Katrina in 2005, the federal, state, and local governments in the immediate New Orleans metropolitan region have spent some $20 billion on the USACE's "Hurricane & Storm Damage Risk Reduction System" (Schwartz 2018). The system largely follows the spatial alignments and strategy of the pre-existing levees and pumps. It strengthened or replaced existing levees and floodwalls and added new deployable and fixed closure structures to block storm surges (Figure 5.1).

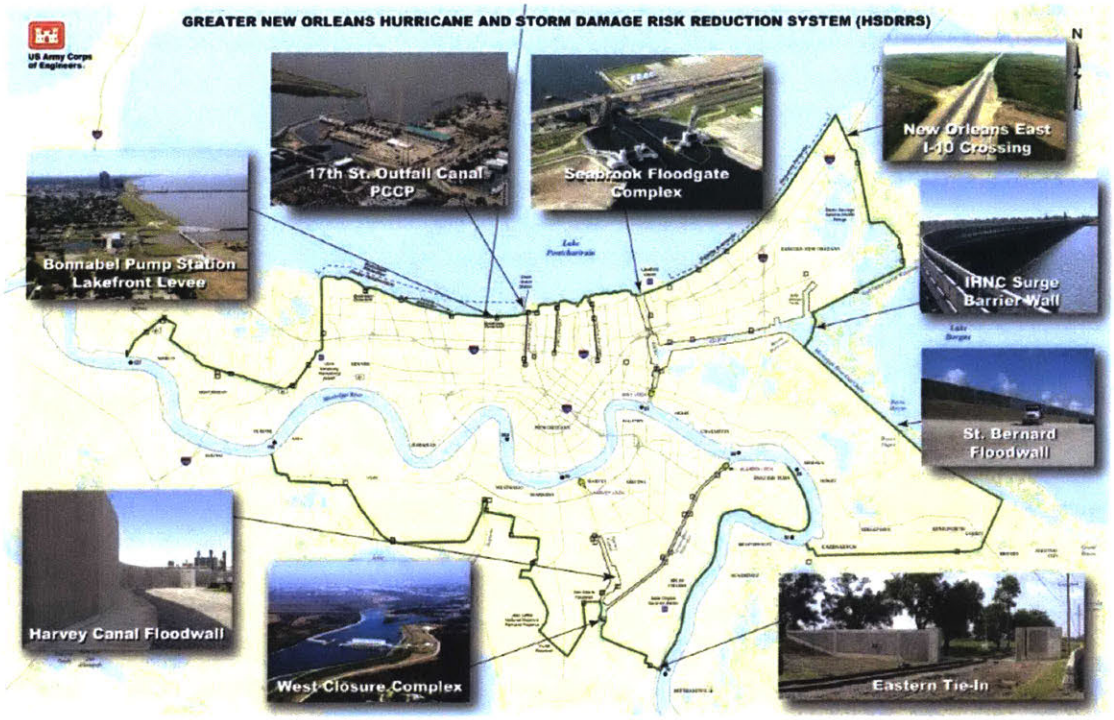

Figure 5.1. Post-Katrina reinforcement of New Orleans' dry city infrastructures.

Dhaka

Water engineering authorities in Dhaka are currently building supplemental pumps at Goramchatbari to address waterlogging within the Western Dhaka embankments. The BWDB and other hydrocracies are also continuing to press forward with plans for the Eastern Bypass embankment and pumps to secure and drain eastern Dhaka (Dasgupta et al. 2015). While the scheme largely matches that put forward in the FAP 8a plan in the early 1990s, the pumping and retention strategy has been revised to address the dramatic increase in landfill based urbanization in the area, which has limited the space available for stormwater retention (Institute of Water Management 2016).

Internal Softening

New Orleans

In the years since Hurricane Katrina, there have been several private and state-sanctioned efforts to increase stormwater retention and infiltration inside New Orleans' levees. In 2013, Waggonner and Ball Architects released the *Greater New Orleans Urban Water Plan* following several years of ongoing design-oriented work with Dutch water experts (Waggonner & Ball 2013). The plan laid out an ambitious agenda for remaking the fabric of the city, embracing a vision of "living with water." This approach has been embraced and carried forward in the city government's subsequent *Resilient New Orleans Strategy* (2015). A number of pilot projects are completed and underway, including those in the *Gentilly Resilience District,* a federally-funded effort to build new green infrastructure in one low-lying neighborhood.

Dhaka

The combination of extreme population density and weak spatial governance institutions have limited the capacity of city leaders in Dhaka to protect existing stormwater retaining wetlands or to create new spaces for retention and infiltration (General Economics Division 2016). Even so, a few large-scale

projects have proceeded in recent years. Recent efforts have advanced what architect Iqbal Habib calls "water urbanism," which includes removing encroachments and dredging to increase the retention capacity of several lakes in the posh neighborhoods of Dhanmondi, Gulshan, and Banani. The most high-profile internal water retention project in Dhaka is the Hatirjheel project, a 300-acre water retention project that also included construction of new pumping stations, road and bridge infrastructure, and public green space.

Regional Restructuring

New Orleans

There have been two major efforts to address larger landscape-scale vulnerabilities in New Orleans and surrounding communities. Beginning in 2007, the State of Louisiana's Coastal Protection and Restoration Authority (CPRA) started an ongoing Coastal Master Planning (CMP) process to systematically assess and prioritize projects to slow coastal land loss and protect existing settlements in the state's southern coastal region. The plan is updated every five years with new projections for land loss and climate change. In 2012, a coalition of philanthropic and non-profit actors organized the Changing Course competition to complement and extend the CMP process. Changing Course was modeled on the post-Sandy Rebuild By Design competition in the New York metropolitan area. It brought together multi-disciplinary design-led teams to generate visions for "navigating the future of the Lower Mississippi River Delta" ("Changing Course" n.d.). The competition yielded three finalists. Each team included Dutch water experts and each presented similar visions for reshaping the hydrology and settlements of the lower Mississippi River over the next 100 years. While both the CMP and the Changing Course competition include broader territories of coastal south Louisiana, protecting the settlements, infrastructure, and industry of New Orleans is an explicit and implicit focus in both cases.

Dhaka

In 2012, the Prime Minister of Bangladesh signed an agreement with the government of the Netherlands initiating an ambitious "water centric, multi-sectoral techno-economic long term adaptive plan" called the Bangladesh Delta Plan 2100 (BDP) (Veerbeek 2016). The BDP was modeled on the Dutch National Water Plan completed in 2009. It brought together teams of Dutch and Bangladeshi experts from a range of disciplines, including economics, hydrology, engineering, and spatial planning and design. Their efforts were organized around seven "hotspots" including "urban areas." Planning efforts for the hotspots included scenario development to generate plans that would be robust to uncertainties in both climatic and socio-economic conditions. While the BDP is national in scope, Dhaka, as the capital and primate city, received significant attention. Flooding and water management are among the central issues in the BDP.

A New Paradigm in Urban Flood Infrastructure?

The people behind many of these projects argue that they are building a new paradigm in urban water management. They describe the new generation of projects as a distinct break from the 20th century Promethean projects of dry city infrastructural modernization. In the face of the dual crises of climate change and urban change, they recognize the failures of previous generations and frame their own interventions as addressing those failings and creating a more conciliatory relationship between city and landscape, between urban and natural processes. For example, the *Resilient New Orleans* strategy report describes its aims as "striking a balance between human needs and the environment that surrounds us" so as to create "a dynamic urban landscape aligned with its natural environment" (City of New Orleans 2015). In many instances, contemporary proposals for realigning settlement patterns with underlying landscape conditions and functions are reminiscent of earlier projects, including the McHarg-influenced proposals for New Orleans and Dhaka discussed in Chapters 2 and 3--particularly the

Pontchartrain New Town In Town in New Orleans (New Orleans East Inc. 1972) and the early 1980s anti-levee DMAIUDP plan in Dhaka (Shankland Cox Partnership 1981a).

In aiming to create this less antagonistic relationship between urban and natural landscapes, many contemporary projects adopt common rhetorical and strategic approaches. Where previous projects are labeled as "gray," "closed," "rigid," "engineered," and "mono-functional," the new paradigm promises to be "green," "open," "adaptable," "ecosystem-based," and "multi-functional." In the face of environmental and social uncertainty, many contemporary flood projects highlight flexibility and adaptation as key attributes, in contrast with the rigidity of previous generations of flood control. Where contemporary projects embrace the language of complexity and socio-ecological systems, they critique 20th century infrastructures as reliant on simplistic and mechanistic understandings of hydrological and social systems. While they present 20th century projects as myopically focused on flood control, advocates present these new projects as multi-sectoral and multi-functional, explicitly valuing non-flood control functions, including ecological, recreational, and economic activities. Given the complexity and scale of the challenges and projects, advocates of this new paradigm for flood infrastructure also call for changes in the institutional, professional, and epistemological foundations of urban water management. To address the urgency and scale of the challenges at hand, these new projects implicitly and explicitly embrace a renewed leadership role for state actors in flood mitigation, sometimes under wholly new institutional governance structures. Many of these projects also advocate for an increasing profile for designers and spatial planners as a remedy for the perceived flaws of previous generations' narrow techno-managerial engineering approach. While the specific contributions and challenges of this increasing role of designers and spatial planners will be the focus of the next chapter, this chapter addresses the extent to which contemporary projects actually represent a new paradigm in urban flood management and what the implications of any shifts may be.

Dutch Water Expertise

While the history of dry city infrastructural modernization in both Dhaka and New Orleans was contested throughout (see Chapters 2 and 3), criticisms and calls for alternative models have grown louder in recent years. The increased criticisms of the Promethean models of 20th century flood control are an international phenomenon. Designers, planners, and other experts from the Netherlands have played a central role in this process. The growing role of Dutch experts in promoting new modes of urban water management is tied to the Netherlands' own flood vulnerability. The culture and governing institutions of the Netherlands have, for centuries, been tied to the struggle to live in a low and flood prone delta landscape (Bijker 2007b). Mid-20th century Dutch engineers and political leaders embraced an aggressive, interventionist vision of flood infrastructural modernization in the deltaic lowlands of the Netherlands, much as they did in the Mississippi and Bengal deltas. Following devastating floods that breached many of the nation's dikes in 1953, the Dutch government adopted the Delta Plan and Delta Works program, which dramatically increased investment in flood protection levees and built massive closure structures to separate the delta landscape from the sea. In his classic book on Dutch water management, *Dredge, Drain, Reclaim: The Art of a Nation,* Johan Van Veen, who is often referred to as the "Father of the Delta Plan," captures the linkages between flood control infrastructure and nation building in the Netherlands in the mid-20th century (Figure 5.2) (Van Veen 1962).

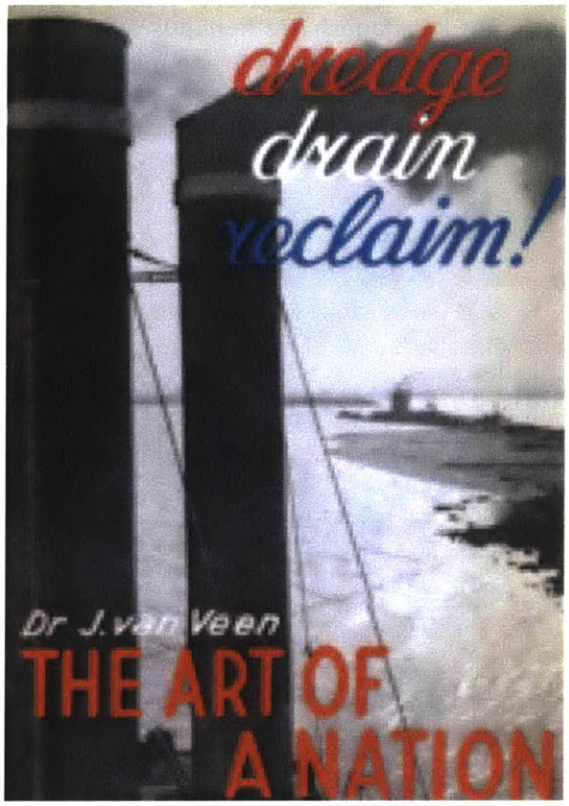

Figure 5.2. Classic celebratory text by Dr. J. van Veen, the father of the mid-20th century Dutch Delta Works program.

After a series of high water events threatened to overtop levees again in the 1990s, Dutch national leaders adopted a series of reforms that shifted flood infrastructure planning, "moving from vertical (dikes) to horizontal (spatial) security provisions" (Warner 2008). Where the previous Delta Works approach constructed a system of structural flood barriers, this new strategy promised to restructure settlement and infrastructure patterns to better accommodate water to avoid the threat of catastrophic failures. In pursuit of these aims, Dutch authorities have carried out a number of projects across a range of scales. Large scale "de-poldering" projects have expanded flood plains in agricultural areas by removing or reconfiguring existing dikes, providing "room for the river" (Schut, Leeuwis, and van Paassen 2010). Within urban areas, a number of projects including "water squares" in Rotterdam, have sought to better channel, retain, and infiltrate rainwater to reduce the reliance on mechanical drainage pumps. This new less adversarial approach to water management has become associated with Ian McHarg's phrase "design with nature" along with other labels like "living with water" (Meyer and Nijhuis 2013).

Though this new approach to water management began as a strategy for coping with climate change and flood vulnerability in the Netherlands, private firms, public agencies, and academic experts which make up the "Dutch Water Sector" now regard water management expertise as a commodity for export (Zaken 2014). Dutch experts have long been involved in flood infrastructure and water management around the world. The cover cartoon image from a 1984 report from Leiden University playfully acknowledges the role of the Dutch in spreading flood infrastructure expertise, showing a Dutchman teaching people from developing nations how to plug a leaking dyke with a finger (Kraakman et al. 1984) (Figure 5.3). This history of water management expertise export has long been mobilized through colonial relations in places like Indonesia (Goh 2015; Yarina 2018), through networks of international aid

in other developing nations, including Bangladesh (Netherlands Water Partnership 2015), and more recently, in cities of the Global North seeking expertise in adapting to climate change, including New York and New Orleans.

Figure 5.3. 1984 cartoon alluding to the tradition of exporting Dutch water expertise to the Global South.

Dutch water experts have been involved in infrastructural modernization in the Bengal delta since the end of British colonial rule[6]. A Dutch water engineering professor, Willem Johan van Blommenstein was a member of the "Krug Mission," the UN effort mounted after the East Pakistan floods in 1954 and 1955 (United Nations Water Control Mission 1959). Dutch-style poldering was extensively deployed in World Bank supported projects in the coastal region beginning in the 1960s and Dutch experts were deeply involved in the FAP efforts of the 1990s. A recent Dutch government report on "50 years of water cooperation" between Bangladesh and the Netherlands reports that beginning in 2012, the relationship between the two countries began to shift "from traditional aid to sustainable trade," focusing on "economic cooperation, investment, and trade promotion" (Netherlands Water Partnership 2015). This linkage between international aid and trade growth is clearly laid out in another recent Dutch government report entitled *A World to Gain: A New Agenda for Aid, Trade and Investment (Zaken 2014)*. With respect to "Transitional" countries like Bangladesh (along with others, including Ethiopia, Indonesia, and Uganda), the report states that,

[6] It is important to note that the Netherlands is far from alone in its sustained interventions in the water sector in the Bengal delta. The US and Japanese governments have also been especially prominent in this area. For a fuller discussion of the role of foreign aid and ideology in shaping flood management in Bangladesh, see Chapter 3.

> Our mission is to combine aid and trade activities to our mutual benefit. We can use the expertise of Dutch companies to develop ports and construct roads. In return, the Dutch private sector will gain a toehold in growth markets. (Zaken 2014)

Spreading Dutch water management expertise around the world is very much a part of this strategy of hybridized aid and trade relations. The Netherlands' *National Climate Adaptation Strategy* released in 2016 proudly states that "Dutch water management expertise represents a valuable export product" (Netherlands Ministry of Infrastructure and the Environment 2016). In this new water knowledge trade, key actors include: private engineering and planning firms like Arcadis; design firms like landscape architects West 8; quasi-governmental research institutes like Deltares; academic institutions like those housed at TU Delft, Utrecht, and Wageningen; and major private construction and dredging firms such as Royal Boskalis Westminster, the largest dredging company in the world.

Like the US-Based "Ambassadors with Bulldozers" of the mid-20th century, these public-private alliances combine self-interested, growth-oriented business with development aid. A recent report on "the business case" for Dutch involvement in climate adaptation in Bangladesh highlights the sector as an opportunity to "market the Dutch approach" to adaptation as "a generic approach" and "a universally applicable methodology for climate proofing" (Bergh, Bucx, and Guchte 2012). By treating flood mitigation and water management technology, expertise, and services as an export commodity, Dutch firms and institutions are seeking to convert the Netherlands' vulnerability to climate change into the defining global economic growth opportunity.

Deltas as Knowledge Markets

To enable the export of Dutch water expertise, advocates have long emphasized the geophysical similarities between the lowland delta environment of the Netherlands and other regions around the world. A map included in a 1984 Leiden University report speaks to the longstanding ambitions to spread Dutch poldering techniques around the world, showing "potential polder areas of the world" on every continent as determined by soil types and hydrology (Figure 5.4) (Kraakman et al. 1984).

Figure 5.4. A worldwide market for water expertise. "Potential polder areas of the world" (1984)

The elevation of the word "delta" serves a similar purpose in many contemporary efforts to link Dutch water expertise to market opportunities in flood vulnerable areas around the world. As sites of rapid urbanization and heightened climate change vulnerability, river deltas, have become a particular locus

of research and climate adaptation planning in recent years (Tessler et al. 2015). At a 2009 conference in the Netherlands, attendees called upon national delegations to:

> recognize deltas as a special category of vulnerability, stimulate the sharing of knowledge and experience, promote education in delta science and technology, facilitate a continuing global delta dialogue (Bergh, Bucx, and Guchte 2012).

Dutch institutions have embraced the "delta" label as a means of connecting the challenges of the Netherlands to a variety of industrialized and developing cities and landscapes around the world. Connecting Delta Cities and the Delta Alliance are Netherlands-based knowledge networks focused on disseminating best-practices in water management in deltas worldwide. In 2008, Delft Hydraulics, renamed itself Deltares and has since aggressively pursued research, consulting, and business opportunities around the world focused on "enabling delta life," including prominent roles in projects in both New Orleans and Dhaka. The most prominent recent Dutch water sector intervention in Bangladesh, the Bangladesh Delta Plan 2100 (BDP), embraces the rhetoric of deltas as the logic for linking the Netherlands and Bangladesh. The BDP is an ambitious effort that promised to bring the new paradigm of Dutch water management and delta planning to Bangladesh. Early visions for the *Delta Plan* called for the establishment of a *Delta Act,* a *Delta Fund,* and a *Delta Commission (Veerbeek 2016)* to remake the legislative, financial, and institutional landscape, all modeled on the *Dutch Delta Plan* (Bergh, Bucx, and Guchte 2012).

In the BDP and in other recent Dutch water sector activities in Dhaka, New Orleans, and other similarly situated cities around the world, design and spatial planning professionals have taken on an increasingly prominent role in the complex multi-disciplinary planning processes aimed at reworking water management in urbanized deltas. The possibilities and challenges of this increased role for design in these projects will be the primary subject of the next chapter. For the purposes of the current discussion, it is only necessary to recognize that design and spatial planning are central to the emerging Dutch water management model that has gained prominence in flood vulnerable regions around the world. In the realms of design and spatial planning, as in Dutch water management more broadly, the "delta" as a transferable category of landscape has taken a central place in promoting this new approach. Prominent Dutch designers like TU Delft's Han Meyer and his students have embraced the term "delta urbanism" as a label for a set of urban design practices shaped by the dynamic landscape processes common in river deltas (Meyer 2014).

The new generation of Dutch water management embraces the McHargian logic of "delta urbanism" that human settlements in delta landscapes should be driven by the underlying logic of landscape processes. This emphasis on the geophysical characteristics of landscapes is presented as a necessary corrective to heavy-handed approaches of previous generations of infrastructural modernization. The approach promises to re-balance relationships between natural landscape functions and urban settlements. By foregrounding the geophysical dimensions, advocates of the Dutch model also make the case for the relevance of their expertise and the replicability of their model in geophysically similar settings around the world. By focusing on the underlying delta landscape, delta urbanism connects otherwise radically different urban settlements from Rotterdam to New Orleans, Shanghai, Ho Chi Minh City, and Dhaka (Edelman 2013; Campanella 2010; Meyer 2014).

While Dutch institutions and firms have developed an impressive expertise in coping with the challenges of inhabiting flood prone landscapes, the aggressive economic growth-oriented marketing of Dutch water management expertise in settings with loosely similar geophysical conditions but divergent urbanization and governance contexts can have serious negative impacts. Several of the cases presented

below suggest some problems that may arise in transferring Dutch water management practices to radically different settings like Dhaka and New Orleans.

A New Paradigm in Urban Water Management in Dhaka and New Orleans?

With the advocacy of Dutch water experts, flood mitigation strategies aimed at realigning the relationship between urban settlements and landscape processes have gained an increased profile in cities around the world. However, recent experience in Dhaka and New Orleans indicate that (1) existing dry city infrastructures are extremely resistant to change, (2) both cities are actually expanding and reinforcing conventional infrastructures; and (3) even those projects that claim to be part of a 'new paradigm' of urban water management may have the same basic biases that have made previous generations of flood mega-projects deeply unwise and unjust. The following three sections explore each of these patterns through discussions of recent flood infrastructure and planning projects in Dhaka and New Orleans.

The Obduracy of Levees

Once in place, dry city infrastructures (e.g., levee and pumps) and the urban settlement patterns that they enable are extremely resistant to change. In the terminology of STS scholars, levees are "obdurate." Dutch STS scholar Wiebe Bijker explains that, "some artifacts are more obdurate, harder to get around and to change than others" and that "the obduracy of sociotechnical ensembles... depends on their function as 'boundary objects' – that is – their ability to create 'inside/outside' boundaries" (Bijker 1995). While Bijker uses of the terms "boundary" and "inside/outside" as abstract concepts rather than material or spatial descriptions, these distinctions clearly apply in the case of levees and allied infrastructures, which are meant to distinctly divide dry from wet and urban from non-urban space. In her work on the obduracy of urban space and socio-technical ensembles, Hommels speaks of urban obduracy as rooted in the relationships between social and material elements of the urban environment that develop over time, saying,

> it is very difficult to radically alter a city's design: once in place, urban structures become fixed, obdurate, securely anchored in their own history and in the histories of the surrounding structures. (Hommels 2005)

Beauregard further links obduracy to the politics of planning, saying,

> Planning interventions require dismantling existing arrangements and redistributing resources and opportunities among various groups. Because they rearrange how people live together and with nature, they are political acts. (Beauregard 2015)

As explained in Chapter 4, the levees in Dhaka and New Orleans have become deeply enmeshed in socio-technical levee complexes whose particular form and dynamics are highly place-specific and historically contingent. New Orleans' levees, in combination with a suite of other technical, regulatory, and social factors, have formed distinct urban edges in many cases. In the context of extreme urbanization pressure and limited financial and spatial governance capacity, Dhaka's levees have become spines of urbanization, so embedded in the emergent urban fabric as to be nearly invisible in some areas of the city. In both cases, these levee complexes are highly obdurate to change, even in the face of mounting criticisms regarding the dangers and unintended consequences of structural flood protection.[7]

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[7] This obduracy of socio-technical ensembles like levees is closely related the concept of path-dependency in politics (Pierson 2000). Where STS scholars use the term "obduracy" to describe the resistance of particular socio-technical phenomena to change, political scientists tend to use "path-dependence" to describe political processes in which the cost of switching approaches grows over time, making these processes resistant to change. While both concepts are useful in analyzing levees, I

Perhaps because they have not suffered a catastrophic failure or perhaps because they have become essential corridors for urban transportation and development, there are no serious discussions of removing or altering Dhaka's existing embankments. In New Orleans, however, the multiple levee breaches that flooded the city during Hurricane Katrina in 2005 brought on a re-examination of these structural flood protections. The emergence and fate of those efforts reveal insights about the obduracy of dry city infrastructures.

New Orleans' Unshrinkable Footprint: Levee Obduracy after Hurricane Katrina

In the immediate aftermath of the levee collapses of Hurricane Katrina in 2005, many mainstream progressive planners and designers regarded the devastation of the city as a demonstration of the fundamental unsustainability of New Orleans' levee and pump-based growth. As Rodolfo Machado, the Chair of Urban Planning and Design at Harvard wrote at the time, the "guaranteed catastrophe" that befell New Orleans "should not have been a surprise" given the "use of generic solutions" and "the disregard of wetlands" that marked the city's development (Busquets et al. 2005). In this view, the post-Katrina recovery presented an unprecedented opportunity to reimagine the city's relationship to its deltaic landscape. Many of the proposals that came out of this initial impulse to reinvent the city in a more landscape-sensitive light suggested "shrinking the footprint" of urban settlement (Meitdrodt and Donze 2005). Like many other observers, Alan Altshuler, the then-Dean of Harvard's Graduate School of Design, spoke of the potential of "significant re-densification, particularly on higher ground" in "highly attractive *waterfront* development" (Busquets et al. 2005). Given the city's demographic shrinkage, such densification would have meant de-densifying lower-lying areas. In a 2006 collection of post-Katrina redevelopment ideas curated by Aaron Betsky for *Artforum,* Los Angeles architects Morphosis proposed a major reduction in the leveed area of the city that would "return" 75% of the city to wetland conditions in what they called a "Great Park" (Figure 5.5) (Betsky 2006). According to Morphosis, this "contraction" would "provide an opportunity to radically transform and improve an urban system" into a "sustainable metropolitan fabric" (Betsky 2006).

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use obduracy to describe the resistance of existing infrastructures to change and I use path dependence to describe the political and economic processes that explain the persistence of levees and other dry city infrastructural modernization.

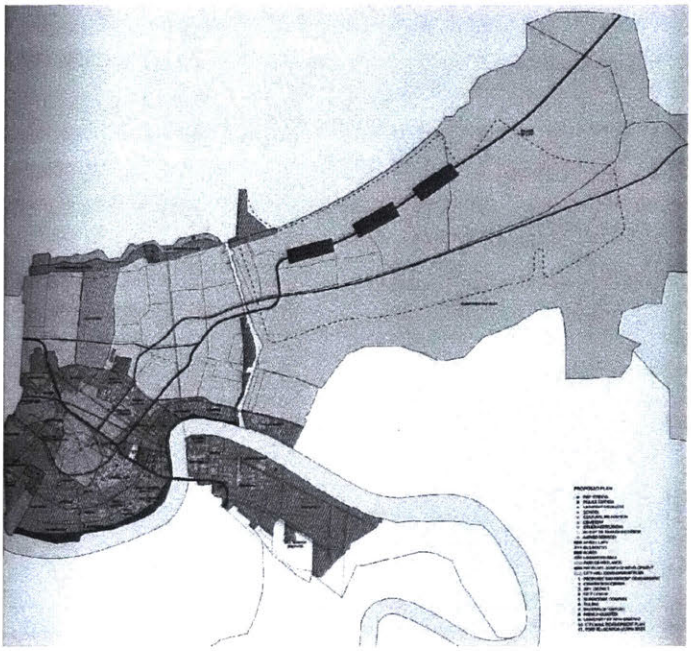

Figure 5.5. A post-Katrina plan for depoldering and radical shrinkage of New Orleans by the California architecture firm, Morphosis. (Mckee 2008)

Like the Morphosis concept, the first officially sanctioned post-Katrina planning effort, Mayor Ray Nagin's Bring New Orleans Back Commission (BNOBC), called for "shrinking the footprint" of the city. While it did not explicitly embrace removing levee protections, the BNOBC plan would have restructured New Orleans' settlement patterns in the name of flood mitigation. The proposal was developed by the planning and landscape firm Wallace, Roberts, and Todd (WRT), building upon the recommendations from a panel of national experts convened by the Urban Land Institute (ULI). Given that WRT is the heir to Ian McHarg's former firm, it is perhaps not surprising that their proposal called for post-Katrina restructuring based largely on a topographic definition of landscape suitability, prioritizing redevelopment on the relatively flood safe areas of the city and proposing that low-lying and heavily damaged neighborhoods be substantially given over to "future parkland" (Bring New Orleans Back Commission, Urban Planning Committee 2006). The BNOBC embraced footprint shrinkage in the name of pragmatic urban efficiency. BNOBC member and local bank executive Alden McDonald argued that "the footprint itself is going to have to be condensed to what we are able to provide services for" since the city's reduced population would not support the level of infrastructure and services that it enjoyed before Katrina (Meitdrodt and Donze 2005). The chairman of the Commission, local banker and real estate investor, Joseph Canizaro similarly made the case for shrinking the footprint because it would not "make economic sense" for utility providers to "provide services to this big land mass" given the reduced post-Katrina population (Meitdrodt and Donze 2005).

As interpreted and presented to the public on January 11, 2006 by the local newspaper, the *Times-Picayune,* the BNOBC proposal came to be known as the "Green Dot Map," with green dots representing six large areas in low-lying parts the city "expected to become parks and greenspace" to better absorb stormwater and consolidate the city's depleted population on more flood-safe terrain (Figure 5.6).

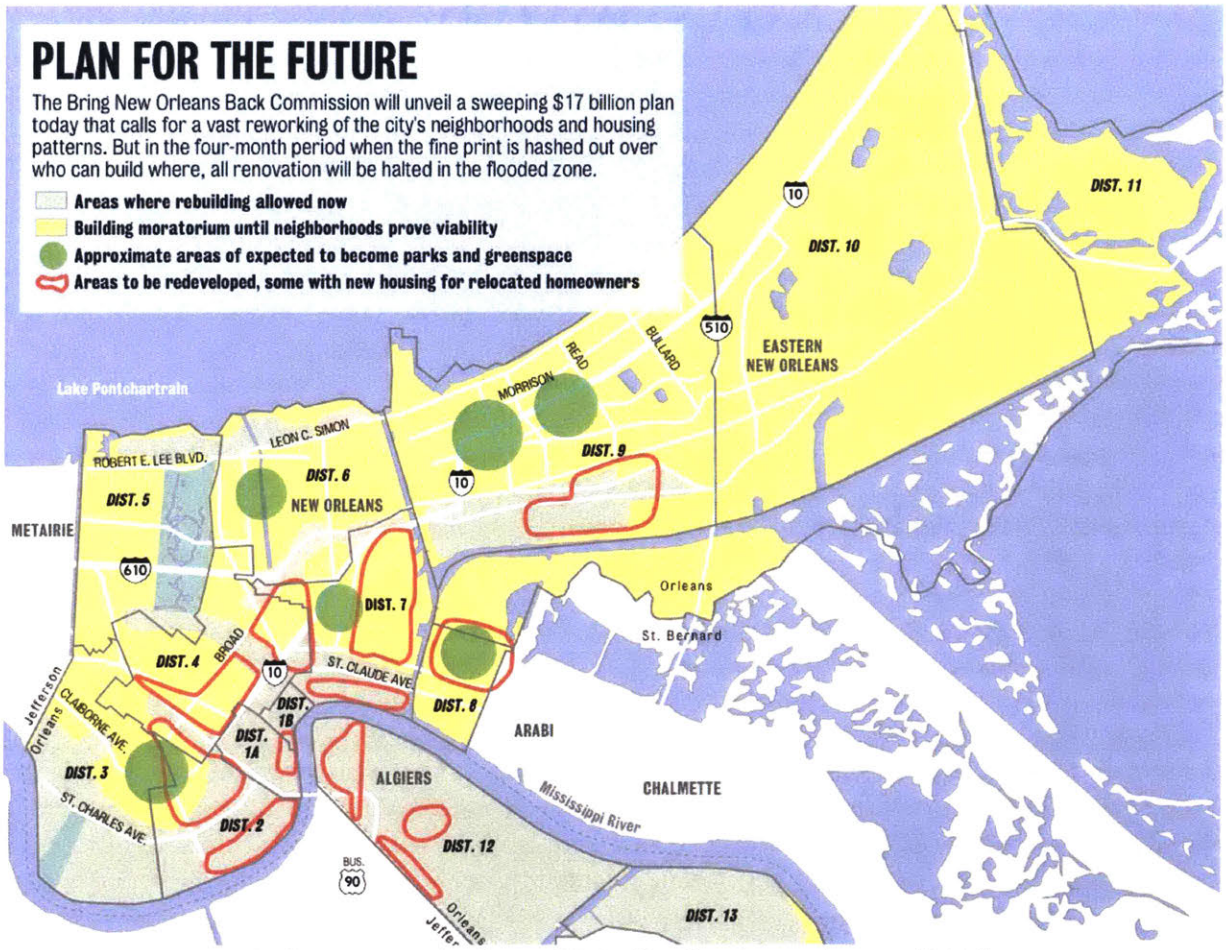

Figure 5.6. The BNOBC's "Green Dot Plan" as published in the *Times-Picayune* (2006).

While the technicians and leaders behind the BNOBC plan appealed to immutability of topography and techno-managerial concerns to make the case for their proposal, the public reactions to the Green Dot Map were swift and overwhelmingly negative (Donze and Russel 2006). The rejection of the Green Dot Map was rooted in a deep distrust of planning among New Orleanians generally and the city's African-American community in particular. Large-scale planning interventions in New Orleans, including such notable examples as the destruction of a major black commercial district to make way for portions of the elevated Interstate 10 through the city, have a long track record of disproportionately impacting the city's African-American neighborhoods. Comments by members of the BNOBC in advance of the public release of their plan suggested to many displaced New Orleanians that this effort would fit with the historical pattern of uneven racially-inflected planning interventions. Less than a month after Hurricane Katrina made landfall, Mr. Canizaro told the *New York Times*, "I think we have a clean sheet to start again...And with that clean sheet we have some very big opportunities" (Rivlin 2005). Another Commission member James Reiss, the chairman of the Business Council of New Orleans, went further in explicitly linking the spatial restructuring of the city to the creation of a new social order when he told the *Wall Street Journal* of the desire to see the city rebuilt "in a completely different way: demographically, geographically, and politically" (Wooten 2012). When the BNOBC's plan was released, it fit the pre-existing narrative of planning as a tool of opportunistic and racist land grabbing. As one New Orleans planner told me, "the Green Dots really just cemented people's skepticism about planning" (Hill 2017).

In the immediate post-Katrina recovery and in the years since, this Green Dot Map episode has shaped the popular perception of centralized planning in general and green infrastructure in particular. Residents of "green dotted" neighborhoods like Broadmoor used the symbol of the green dot as a rallying point against top-down planning and for neighborhood-based recovery, wearing paper-plate green dots around their necks at rallies and even naming the café in the Broadmoor neighborhood's re-opened public library branch the Green Dot Café. Following the rejection of the Green Dot Map, subsequent recovery planning efforts abandoned calls to substantially restructure the city's land use patterns or to significantly change drainage and flood infrastructure strategies. Planners involved in subsequent green infrastructure efforts reported that the Green Dot Map cast a long shadow over their efforts, engendering a stubborn sense of suspicion among many residents. Some twelve years after Katrina, a local urban designer reported that the episode still had clear implications for water planning in the city, saying "everyone is super conscious of the Green Dot fiasco" (Chang 2017a).

Once the immediate post-Katrina proposals for "shrinking the footprint" of New Orleans became associated with racially-tinged top-down planning, discussions of changing existing levee strategies and alignments became politically off-limits. The *Urban Water Plan* (2013), the *Resilient New Orleans Strategy* (2015), and other local and regional efforts to address water management since Katrina have acknowledged both the acute hazards (e.g., catastrophic levee failures) and chronic problems (e.g., subsidence and enabling of poorly adapted urban settlement patterns) caused by the region's dry city infrastructures. However, even the most long-term and visionary planning exercises treat the existing levee alignments as fixed site conditions. The *Water Plan* and *Resilience Strategy,* both identify the city's levees as an essential component of a strategy employing "multiple lines of defense," from the "curb" to the "coast" in the words of one local leader (Hebert 2017). Though the *Water Plan* observes that "Katrina revealed all" of the mistakes and miscalculations of previous generations' water management in the city, the plan "focus[es] on water within the levees" and avoid discussion of major shifts in infrastructure or land use like those suggested after Katrina (Waggonner & Ball 2013).

While planners, designers, and city officials have continued to pursue green infrastructure for stormwater management in New Orleans, the resources dedicated to these efforts pale in comparison to those that have gone towards conventional dry city infrastructure efforts. The most significant post-Katrina green infrastructure project, the Gentilly Resilience District, will spend some $141 million in federal HUD funding on a suite of landscape-based water management practices. Through this and other post-Katrina projects, the city has spent only a fraction of what the mayor estimated would be billions of dollars required to overhaul the city's drainage system in line with the *Greater New Orleans Urban Water Plan* (Adelson 2018).

While political consensus and resources for green infrastructure investments have been slow in coming to New Orleans, federal, state, and local governments have invested heavily in reinforcing the city's pre-existing levee and pump infrastructure. The USACE led the effort in designing and constructing the post-Katrina Hurricane and Storm Damage Risk Reduction System (HSDRRS), a $20 billion project to provide protection to the city for the 100-year storm surge through levee strengthening, new flood walls, and several new closure structures and pumps. As of the summer of 2018, the system's 133-mile fortified perimeter and 70-miles of internal levees and floodwalls were substantially completed. Because of the urgency with which the project was pursued and the enormous regulatory and political obstacles of moving the levees, the HSDRRS structures largely follow the alignment of the pre-Katrina levees.

While Dutch experts have worked with local designers and planners for many years to change the model of urban water management in New Orleans through such efforts as a series of "Dutch Dialogues"

workshops (Meyer, Morris, and Waggonner 2009) and the *Urban Water Plan*, the USACE and their local counterparts, the Sewerage and Water Board (SWB) and levee boards, remain committed to conventional dry city infrastructures. In addition to the HSDRRS, the USACE is also finalizing the Southeast Louisiana Urban Flood Control Project (SELA), a series of upgrades to the drainage systems in the region designed to cope with the 10-year rain event. In the SELA project, which was originally authorized in 1998, the USACE has spent over $1 billion reinforcing conventional drainage systems in Orleans Parish. Speaking of the disconnect between the new Dutch water management best practices and the prevailing approach in New Orleans, a USACE official said,

> One of these [Dutch] guys came in and described to us how they are trying to maintain the groundwater levels and slow down the infiltration process using green space. I was like, "Wow, this SELA thing is basically the furthest thing from that you could imagine." It's like this giant concrete and steel box to channel water as fast as possible to pumps."

A Highly Constrained Vision

Though these new investments are projected to protect against the 10-year rain event and 100-year storm, climate change and coastal land loss are rapidly amplifying those risks, calling into question the long term future of New Orleans' protections. In just five years, what had been the worst case scenario for land loss projected in the 2012 Coastal Master Plan became the best case scenario by 2017. However, even planning efforts that are intended to be long-term, large-scale, and visionary in spirit have not considered the long-term viability of New Orleans' existing levee alignments and strategy. The two most prominent recent examples of such plans are the Coastal Master Planning (CMP) process and the Changing Course competition. While both of these efforts were conceived of as large-scale planning exercises to address the long-term threats of land loss and climate change in New Orleans and the coastal region, neither effort overtly questions the long-term viability of New Orleans' levees.

The CMP is an ongoing state-led planning process focused on slowing coastal erosion and protecting the resources, infrastructure, and communities of the South Louisiana coast. The CMP is framed as a modeling-driven "science-based coastal planning" process. It is updated every five years to reflect changes in the geophysical and socio-economic conditions on the coast (CPRA 2017). While the CMP has been praised for its adherence to norms of scientific analysis and planning, the limited range of future scenarios that the plan considers speaks to the obduracy of the current levee complexes.

The 2017 CMP stated for the first time that it will not be possible to restore the coast to its pre-levee conditions. Given the rate of land loss, the plan projects that some areas of the lower delta cannot be preserved and will have to be abandoned. Despite these alarming findings, the CMP does not consider the question of the long-term viability of New Orleans' levees. To the extent that the CMP addresses New Orleans' levees at all, the plan doubles down on the conventional dry city infrastructure approach. Among the projects recommended in the 2012 and 2017 plan is the Greater New Orleans High Level protection project, which would reinforcing the existing levees to meet a 500-year protection standard over the next 30-50 years (CPRA 2017). Even in the CMP planning process, which was explicitly designed to be neutral, non-political, and quantitative, major shifts in water management for the city and region are too politically charged to discuss. As a local journalist told me, to consider reducing the extents of the city's levee protections would be read as "retreat," and "politicians can't talk about retreat" (Marshall 2017).

Responding to the limitations of the CMP, after the second plan was issued in 2012, a group of philanthropic and non-profit advocates initiated the Changing Course competition. The Environmental Defense Fund and the Van Alen Institute launched the competition with the financial support of the

Rockefeller Foundation in September 2013. While CC had the "support and participation of the State of Louisiana and the U.S. Army Corps of Engineers" ("Changing Course" n.d.), the competition was not government funded or officially sanctioned. As such, organizers hoped to remove some of the political constraints that had limited the CMP and to enable the generation of more radical and forward thinking proposals. A local planning official in New Orleans said that "It's good that [Changing Course] wasn't a state plan...They could push a little more" and include "some provocative stuff" (Hebert 2017). As one participating designer said, "the reason they did the competition was that they thought the Coastal Master Plan wasn't going to go far enough" (Agre 2017).

The Changing Course competition was explicitly initiated to extend the CMP process into more radical directions. However, even in this context, New Orleans' newly reinforced levee systems proved to be resistant to even the consideration of change. Organizers reported that the competition explicitly focused on the area downstream from New Orleans because they "didn't want to be too revolutionary" in suggesting changes to the city's levees themselves (Cochran 2017). One organizer said that "shrinking the footprint [of New Orleans] really wasn't on the table," but offered the opinion that that limitation was "kind of a shame." By way of explanation, they said that "there has just been this immense investment in the current levee systems" and that there was simply no appetite to revisit the politically fraught post-Katrina discussions of footprint shrinkage (Peyronnen 2017). A member of one of the three final teams in the competition reported that "It was kind of taken as a given that [New Orleans' levees] would be maintained with the post-Katrina configuration. There was sort of no need to look further into this" (Minns 2017). A designer on another of the winning teams concurred, saying,

> I think everyone said, "New Orleans has built this $14 billion levee. They are going to be there. No one was willing to take on those conversations... No one wants to hear that New Orleans won't be there in 70 years. (Carney 2017)

As in the more politically constrained Coastal Master Plan, the CC competition largely embraced the conventional levee alignments and strategies for New Orleans. Though several participants and organizers described the competition as aimed at generating "out of the box thinking," the teams stayed well within the box of the city's existing levees.

The Dimensions of Levee Obduracy

As with other obdurate urban patterns, the resistance to change exhibited by New Orleans' levees is born out of the historically-evolved embeddedness of those levees within broader socio-technical and socio-natural networks. Once in place, levees and associated infrastructures create feedback mechanisms, which make them difficult to remove or change. Some of these feedback mechanisms are geophysical or hydrological in nature. Examples of such *physical obduracy* mechanisms are present in both Dhaka and New Orleans. In both areas, observers have noted that riverside embankments or levees lead to siltation of riverbeds, raising water levels and requiring levees to be periodically elevated to keep up (Mukerjee 1938; Rogers, Lydon, and Seckler 1989). The subsidence observed in many areas of New Orleans is another mechanism of physical obduracy. With aggressive leveeing and pumping, organic-rich soils oxidize, dry, and compact, leading the ground within the leveed zone to sink, requiring ever more pumping and leveeing to keep the areas free of water (Waggonner & Ball 2013). While similar subsidence has not been a major issue in Dhaka to date because of the relatively stable soils underlying the older parts of city, eastern Dhaka, where much of the city's most recent growth has taken place, is characterized by less stable soils which could be subject to subsidence if planned levees and pumps are completed in the area (Higgins et al. 2014).

While physical obduracy can play an important role in locking-in particular technological paths of urbanization, Dhaka and New Orleans also demonstrate that these geophysical processes are

interwoven with multiple mechanisms of *political obduracy*. First, there is the basic idea that people are resistant to losing perceived assets or benefits once they have been granted. Behavioral economists have labeled this phenomenon 'loss aversion' (Thaler and Sunstein 1999). A senior water engineer involved in the Changing Course competition and the Louisiana Coastal Master Plan spoke to this tendency to resist changes to protective status, saying,

> If Mother Nature changes something, that's one thing. People will deal with that. But if you decide not to protect me or if you do something that changes the trajectory … people don't want it. (Wilson 2017)

Revoking structural flood protection may be especially politically problematic when the people that will experience that loss see other groups or places benefiting from the same change that harms them. Though Dutch "room for the river" projects are promoted as models around the world, these depoldering projects have led to serious conflicts as rural farmers resist giving up the perceived security of dyke protections to reduce flood vulnerability in nearby urban areas. In the words of one landscape architect who worked on a large depoldering project in the Noordwaard area in the Netherlands, "People in Noordwaard feel that they have been sacrificed for the people in the city along the river" (de Konning 2017).

In New Orleans the political resistance to changes in levee regimes is linked with the historically-rooted distrust of top-down planning in the region, including the legacies of both race-based displacement and the treatment of rural areas as sacrificial landscapes to protect and preserve urban property and interests. The immediate and vociferous opposition to the Green Dot Map and other post-Katrina proposals for "shrinking the footprint" of New Orleans were rooted in the historical legacy of racialized displacement. Rural communities outside of New Orleans also have a well-earned distrust of state infrastructure planning that has privileged wealthy urban interest at the expense of rural communities. One of the organizers of the CC competition spoke to this urban-rural tension saying, "Everyone south of New Orleans hates New Orleans because they get everything" (Cochran 2017). The tensions between urban and rural interests in south Louisiana are also based on an historically-rooted suspicion that, as in the case of the Noordwaard depoldering, rural lands, people, and livelihoods will be sacrificed to protect the city. Perhaps the most dramatic historic example of this urban bias is the intentional breaching of the Mississippi River levee in rural St. Bernard Parish to save New Orleans from the great floods of 1927 (Barry 1997). Though it happened nearly a century ago, the intentional flooding of this downstream rural community still looms large in the collective imagination of disempowered communities in both urban and rural areas (J. A. Lewis and Ernstson 2017). The suspicion that rural communities will be sacrificed to protect New Orleans has shaped planning efforts like the CMP and the CC competition, inviting resistance to any proposal that would displace rural communities or suggest 'managed retreat'. As one Changing Course team member explained it, "In some of these [lower delta] towns, if you start talking about retreat, you will have to be escorted out of the room" (Carney 2017).

Other mechanisms contributing to the political obduracy of levees are associated with the levee effect, the pattern discussed in Chapter 4, wherein, once levees and drainage infrastructures are in place, they enable both *more development* and *less flood-adapted* development. While the patterns in the two cities are somewhat different (see Chapter 4), levee-based urbanization in both Dhaka and New Orleans has enabled population expansion in landscapes previously subject to regular inundation. As such, to revoke the promise of structural flood protection would impact many more people than had an interest in the area before the infrastructural intervention. In parallel with this *population effect,* the two cities also demonstrate a *fragmentation effect,* wherein levees lead to more fragmented forms of property ownership. In both Dhaka and New Orleans, levee-enabled urbanization has brought on increasing fragmentation of ownership in areas that once had relatively consolidated ownership. Thus, any change

in water management that would impact these fragmented landscapes must be accepted by a larger number of stakeholders. Finally, when levees are built, the development that follows often reflects a "false sense of security," in that settlement patterns and building practices in newly levee-protected areas are less able to cope with flood hazards. Changes in flood infrastructure regimes that remove or restructure levee protections would disrupt patterns of living and settlement that have developed based on previous expectations of protection. While the extent and form of these reductions in adaptation are highly heterogeneous (see Chapter 4), this *reduced adaptation effect* is visible in parts of both Dhaka and New Orleans.

	Dhaka	**New Orleans**
Physical Obduracy	Settlements on levees; Riverbed sedimentation.	Subsidence; Riverbed sedimentation.
Political Obduracy	Loss aversion; Population effect; Fragmentation effect; Reduced adaptation effect.	Distrust of top-down planning, including race based and rural-urban tensions; Loss aversion; Population effect; Fragmentation effect; Reduced adaptation effect.

Table 5.2. The physical and political obduracy of urban levees in Dhaka and New Orleans.

Even in the face of mounting criticism of conventional dry city infrastructures and increasing interest in alternative forms of urban water management, these cases make clear that levees and the patterns of urbanization that they have enabled are highly obdurate. This obduracy is rooted in the particular form and dynamics of place-specific levee complexes. The mechanisms that contribute to this levee obduracy hinge on the tendency of prior infrastructure interventions to shape natural processes (e.g., pumping induced subsidence), historical process (e.g., the distrust of large planning interventions in south Louisiana), and the socio-spatial transformations of urban landscapes. While some of these processes are seen in both Dhaka and New Orleans, others are place-specific and historically contingent.

The Persistent Appeal of Dry City Infrastructural Modernization

Not only have existing levees and levee-enabled urbanization proven to be highly obdurate in Dhaka and New Orleans, both cities have seen new investments in reinforcing and expanding conventional infrastructures. Even as leaders in both cities have increasingly deployed the rhetoric of 'resilience,' and called for adopting 'flexible,' 'adaptive,' and 'nature based' strategies for coping with flood hazards, conventional dry city infrastructure mega-projects have a persistent political and economic appeal. The following sections recount major ongoing investments in conventional levee and pump mega-projects and consider the ways in which intertwined material interests and epistemological factors have contributed to deeply path-dependent processes supporting this enduring appeal.

As noted above, in the years since Hurricane Katrina, local, state, and federal governments have spent an enormous sum in reinforcing New Orleans' conventional structural protections against flooding. Even long-term, large-scale planning efforts like the CMP and the CC competition have embraced the conventional levee and pump-based strategy. Over the next 50 years, the 2017 CMP calls for spending an additional $19 billion on structural flood protections and shoreline protection, more than triple the amount dedicated to "nonstructural" adaptation measures like building elevation or buyouts for managed retreat (Figure 5.7).

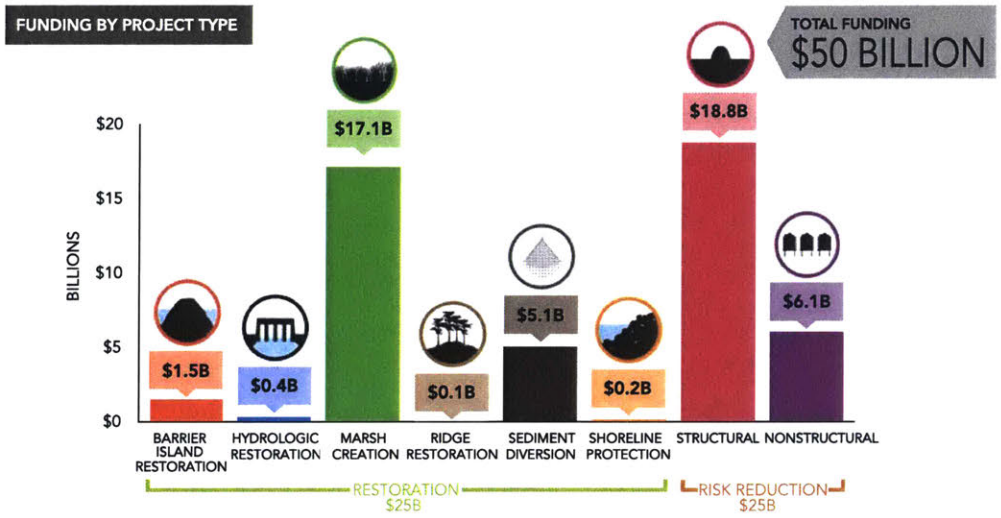

Figure 5.7. Budget allocation from the 2017 Louisiana Coastal Master Plan. The plan's proposed funding for "risk reduction" projects as shown in the two right-most bars, show an enormous enduring bias in favor of structural protections as compared to non-structural strategies.

In Dhaka, as in New Orleans, even as criticisms of dry city infrastructures have mounted, investments in these problematic strategies continue to grow. In both project-based planning and broader regional and national planning, conventional engineering approaches dominate.

Dhaka's Eastern Embankment

As discussed in Chapters 3 and 4, when Dhaka's first major structural flood protections were built in the early 1990s, one half of the planned embankment system was built around the more urbanized western portion of the city. At the time, the less urbanized low-lying eastern portion of the city was not empoldered due to resource constraints. The so-called "eastern embankment" or "eastern bypass" project has been proposed on multiple occasions in the decades since, but the area remains unembanked and subject to seasonal inundation from the Balu and Shitalakya River. As discussed in Chapter 4, in the absence of collective flood protection, much of this area has been elevated via landfilling by private real estate developers over the last two decades.

While the eastern embankment has been repeatedly proposed in recent years, many critics in Dhaka regard the project as problematic and largely unnecessary. A recent article in the *Daily Star* newspaper made the case that "cordon approach" proposed for the eastern embankment would simply repeat the "same mistake" of the western Dhaka embankment, causing waterlogging, biodiversity and wetland loss, and high maintenance and operations costs ("Eastern Bypass: The Same Mistake Again?" 2016). Drawing on the views of longtime levee critic Nazrul Islam, the article argues for an "open approach" that would allow for the area to remain hydrologically connected to the surrounding rivers, "let[ting] the delta be a delta" (Islam 2016a). Rather than building cordon embankments, Islam advocates for a return to settlement patterns that are better suited to natural delta hydrology. He says that "settlements in the delta should follow the dig, elevate, dwell principle that they have followed for centuries" (Islam 2017). For Islam and other like-minded observers, the landfill-based urbanization practiced in unembanked eastern Dhaka is both problematic and promising. They are disturbed by the social and ecological costs of these practices, which destroy the existing wetland landscapes and the livelihoods that rely on them.

They are alarmed by the political power and corruption of the land developers who blatantly ignore planning and environmental regulations. And yet, for critics of the levee and pump-based "cordon approach," this landfill urbanization represents an adaptation of a more appropriate mode of settlement. Speaking of the largest land developer in eastern Dhaka, Islam told me,

> this is the right approach... Bashundhara did this on its own... The only good thing here is... because there is no embankment built, people who build had to bring in sand... to make the site safe for building." (Islam 2017)

Another Dhaka planner expressed the sentiment that, with the massive landfilling, the eastern Dhaka embankment is not unnecessary, saying, "now they are building at the level of the embankments... there is no need for embankments if they are developing above the flood grade" (N. K. Rahman 2017).

Despite the mounting criticism of the eastern embankment project and the sense that it is no longer functionally necessary, many within the government and international lending institutions continue to push for the expansion of levee-and-pump based urbanization in eastern Dhaka. The World Bank has repeatedly studied the prospects of financing the eastern embankment. A 2016 internal Bank document entitled *Unlocking Disaster Resilient Urbanization of Dhaka East,* makes the case for the embankment on the basis that the infrastructure would save private developers billions of dollars in landfilling costs (World Bank 2016).

Even as the World Bank advocates for the revival of the eastern embankment, Bank officials in Dhaka reported that they are unlikely to finance the project in the near term because of concerns over its environmental and social impacts. One official reported that the Bank is taking a very "risk averse" and cautious approach to the eastern embankment project "because this is Dhaka and because of the visibility... and because of all of our [environmental and social] safeguards."

In spite of the World Bank's hesitancy to fund the project, the Bangladesh Water Development Board (BWDB), the national agency responsible for flood protection infrastructure, remains committed to the eastern embankment project. The BWDB has begun looking to alternative sources of financing. In 2016, they received a proposal to build the project from a quasi-state-owned Chinese engineering and construction firm. The firm, AVIC International is a spinoff of the Aviation Industry Corporation of China, which is active across a range of sectors from military and civilian aviation to ship building to major civil engineering projects. In their tone and approach, AVIC resembles the mid-20th century international boosters of infrastructure modernization in the eastern Bengal delta. Like these earlier "Ambassadors with Bulldozers," the Chinese firm operates in an ambiguous space between public and private enterprise, advocating a vision of interventionist infrastructural modernization in Bangladesh. Unlike the World Bank, AVIC is not constrained by environmental and social safeguards. This Chinese proposal for Dhaka's eastern embankment marks a return to a more 'pure' form of infrastructural modernization in which investments in conventional infrastructure promise transformative change. Like the mid-century proposals for heroic infrastructural modernization, the 2016 AVIC report uses images to suggest that this embankment project is all that stands between Dhaka's challenges and a modern, clean, and prosperous future. Renderings of the proposed embankment project include well-tended topiaries, speeding bullet trains, and wide traffic-free highways passing through streetscapes of identical high-rise buildings (Figure 5.8). The proposal drawings show the eastern embankments maintained in pristine infrastructural purity, with no hint of the "encroaching" development that has characterized the western embankment, where the infrastructures have become spines of urbanization (see Chapter 4).

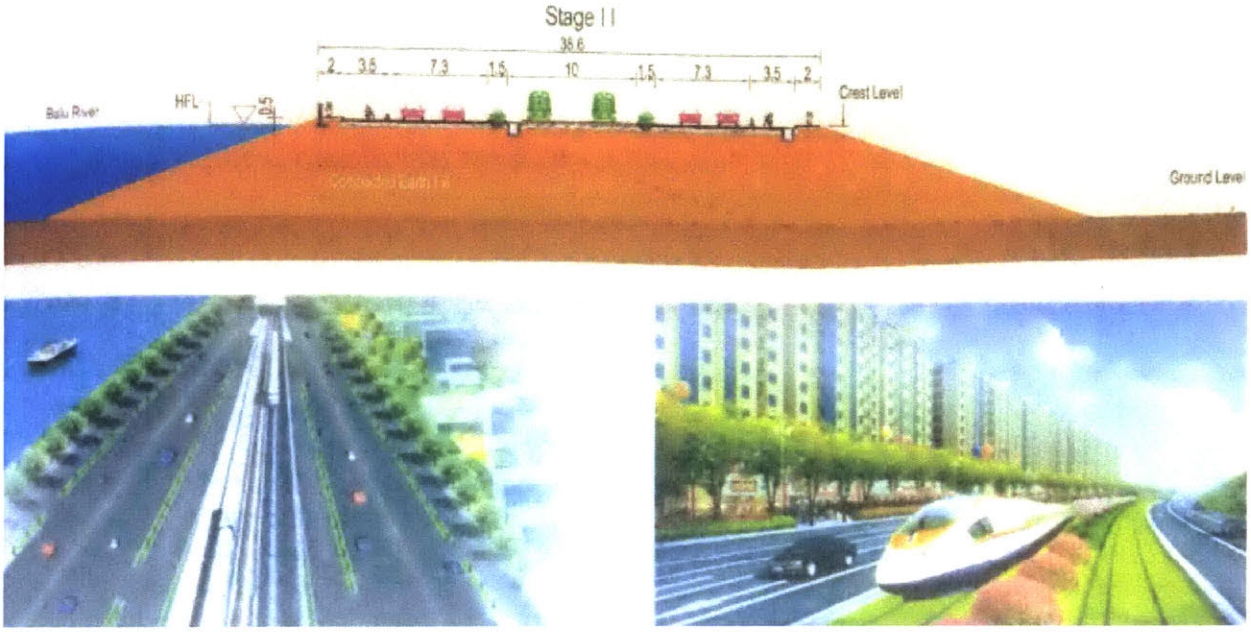

Figure 5.8. A new generation of 'Ambassadors with Bulldozers' for Dhaka. Images from a proposal for eastern Dhaka's embankment by Chinese firm AVIC. (2016)

Bangladesh Delta Plan 2100: New Rhetoric, Old Projects

As in New Orleans, in Dhaka even large-scale, long-term planning processes that promise to change the paradigm of regional water management have largely embraced and endorsed conventional mega-projects. The most prominent recent example is the Dutch-funded Bangladesh Delta Plan 2100 (BDP). The BDP promised to bring the Dutch model of "adaptive delta management" to the Bengal delta as an alternative to rigid 20th century water infrastructure modernization. The BDP process used scenario-based planning to develop water management strategies that would be robust to uncertainties in climate change and economic development. The BDP's *Inception Report* stated that the plan would "be formed using methods developed in the Netherlands" to develop a "delta vision" representing "a holistic approach to future land and water management in relation to water security, food security and socio-economic development" (Consultant Team BanDuDeltAS 2014).

The BDP identified "urban areas" as one of seven "hotspots" around which research and planning efforts were organized. The leaders of the *Urban Areas Strategy* team were De Facto Architecture and Urbanism, a Rotterdam-based design firm headed by Anne Loes Nilleson, a student and collaborator of Han Meyer, one of the originators of "delta urbanism" at TU Delft. The BDP's *Urban Areas Strategy* report lays out several strategies for urban flood mitigation that are in-line with the contemporary Dutch practices of using "green and blue spaces in urban areas" to both manage fluctuations in stormwater and to "sustain and support an urban ecology and create livable cities" (General Economics Division 2016). These strategies include prototypical designs for "improved khals" or canals and floodable neighborhoods and waterfronts.

In most cases, these proposals replace vertical strategies like dikes and floodwalls with horizontal strategies like floodable landscapes. In interviews, Nilleson said that she advocates for such horizontal, distributed, and urban design and landscape-based strategies because she is "skeptical of large

interventions" like major levees or embankments given their track record of the unintended consequences. She says,

> I am very concerned about how often we discover new knowledge... We treat our current understanding as if it is objective fact, but again and again we make new discoveries that fundamentally change how we view our projects and their contexts. (Loes Nilleson 2017)

As an example of such hard learned lessons, Nilleson points to mid-20th century Dutch structural flood protections in which they "designed these beautiful dykes with the angles just right and everything, but we completely missed the ecology." Nilleson recognized that for Dutch water experts operating in Bangladesh, there is an added level of professional humility necessary since "the Netherlands is really a sort of beginner situation compared to Bangladesh. We don't have heavy rains. We don't have earthquakes." In this framing, the problematic history of heavy-handed flood interventions and the radical difference in context between the Netherlands and Bangladesh all weigh heavily against flood infrastructure mega-projects.

This skepticism of mega-project flood interventions is reflected in a metaphorical binary that appears in the BDP planning documents. The BDP's *Urban Areas Strategy* report groups strategies for urban drainage and flood control into two broad categories: "engineered control," which is labeled as "Banyan" after the stout and strong south Asian tree species; and "adaptation by design," which is labeled as "Shapla" after the water lily, whose flexible structure allows it to adjust to changing water conditions. In addition to symbolizing adaptability, which comports with contemporary Dutch water management ideals, the Shapla is also Bangladesh's national flower, giving the metaphor additional symbolic and political power. The BDP *Urban Areas Strategy* includes national scale maps with indicative proposals for how the Banyan and Shapla approaches might guide divergent paths forward with respect to urban protections and other issues. The Banyan option shows "dike ring areas that include the main part of the countries area" [sic]. The Shapla option includes "smaller dike rings that protect the more densely built urban areas," while the outside area "keeps its 'living with water' characteristic" for "functional," "national identity" and "tourist potential" purposes (General Economics Division 2016). At the national level the Shapla option was projected to deliver benefits on a number of fronts, both instrumental and symbolic. Interviews with other participants in the BDP process suggest that the more flexible and less interventionist approach to water management had some purchase. A senior official with the BWDB, Bangladesh's levee building bureaucracy, reported, "my personal view is that it is best to not do flood control. [It is] better to live with flood" (M. Rahman 2017).

In spite of the appeal of the "adaptation by design" or Shapla approach, many participants reported that the BDP failed to deliver a new paradigm of water management and has been coopted to justify more conventional mega-projects. In the end, both the Banyan and Shapla options presented in the *Urban Areas Strategy* included major new embankment projects to protect Dhaka and other urban areas with the only discernable difference being small variations in the scale and extents of the levees. Maps in the document show the "engineered control" Banyan strategy for the Dhaka metropolitan area surrounded by a ring embankment described as "providing a very high safety level to the economic heartland. Protection of lives and assets." On the "adaptation by design" Shapla map, a nearly identical area is shown with "high safety level, heavy embankment protection" (Figure 5.9). In both cases, the maps show embanked areas that are considerably larger than both the current western embankment and the proposed eastern embankment. In spite of the fact that Nilleson said that she was "not a big fan of the eastern levee," the *Urban Areas Strategy* report includes the project among the "short term projects" recommended for investment (General Economics Division 2016).

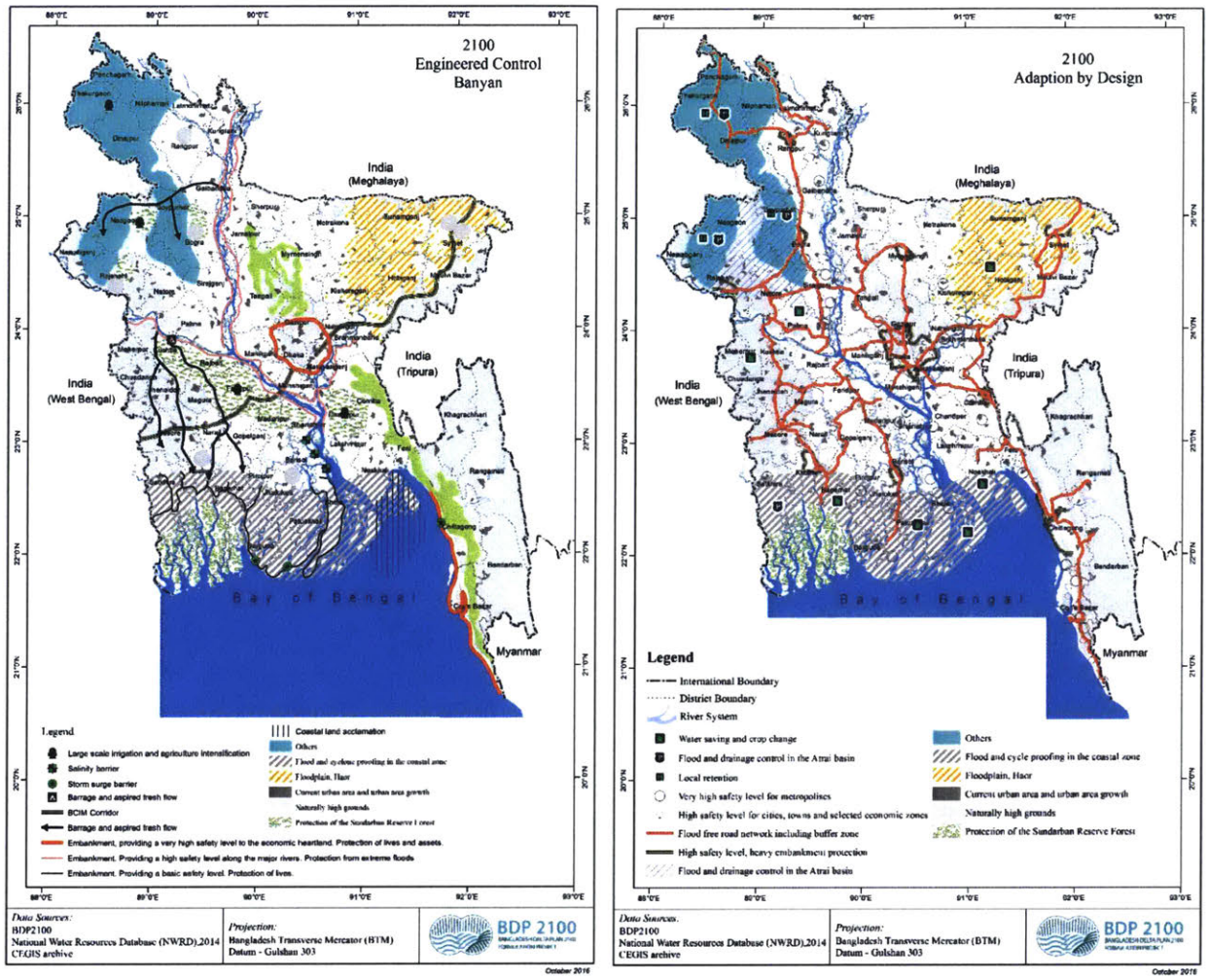

Figure 5.9. Maps showing the BDP's "Banyan" (left) and "Shapla" (right) options. While the proposals are substantially different at the national scale, both options show new enlarged embankments for Dhaka.

While the inclusion of the Dhaka eastern embankment in the BDP may be surprising given the anti-interventionist 'living with water' rhetoric of many of the people involved in the process, the eastern embankment is just one of many such pre-existing mega-project proposals that are now being justified through the BDP process. One Bangladeshi critic said of the BDP,

> It will just be another mega project. Same old stuff… build more dikes. They have all these fancy new words. These "hotspots". This fancy new "process design" and glossy materials. But it is all the same old stuff." (Islam 2017)

A senior BWDB official who worked on the BDP concurred, saying that the projects that will emerge from the planning process are "mostly traditional or pre-existing or ongoing or already planned" and that "no innovative projects are there." Another senior Bangladeshi water planner reported that "what the Dutch imagined or wanted to do [in the BDP] did not succeed in terms of creating a paradigm shift" and that "there is no real change of direction." He went on to say that whereas in the Netherlands "they have done 'room for the river'," "when they come to Bangladesh, they just want to do it their way," returning to old-fashioned mega-project approaches that have been largely discredited in their own country (S. Alam 2017).

While the BDP started with sweeping ambitions for remaking the institutions and strategies for water management in Bangladesh, it has ended up largely providing a means of selecting and prioritizing among previously proposed projects. One senior Bangladeshi water engineer who worked on the BDP specifically spoke to the disappointment that the process has not delivered on bringing Dutch water management to Bangladesh, saying,

> If they had adopted Dutch delta planning, that would have been great, but technically, there are no new ideas. It is all old things being rehashed... from 1972... 1964" (Nishat 2017).

While the BDP was explicitly advertised as a new model of "holistic and integrated" "adaptive delta management," the investment plan that emerged from the planning process is largely a prioritization of many discrete pre-existing conventional mega-projects. In many cases, the plan's rhetoric of climate adaptation, resilience, flexibility, and ecological sensitivity is being mobilized to justify projects, like the Dhaka eastern embankment, which originated in the mid-20th century golden era of infrastructural modernization under the 'Ambassadors with Bulldozers'.

The Abstract Epistemologies and Stubborn Material Interests behind Dry City Projects

Even in the face of widespread critiques of dry city infrastructures, these strategies continue to proliferate into new projects and new territories. As the recent examples from Dhaka and New Orleans illustrate, plans claiming to usher in a new paradigm of water management drawing on Dutch 'living with water' strategies are dedicating the vast majority of their resources to expanding and bolstering conventional levee and pump systems. In explaining the enduring appeal of structural flood protections, Bangladeshi levee critic Nazrul Islam differentiated between two sets of contributing elements: "epistemological" factors and "material interests" (Islam 2017). Recognizing that epistemological and material interests are frequently intertwined and not neatly separable, this distinction is useful in that it recognizes that some of the reasons for the persistence of dry city projects are clearly attributable to interests of material accumulation and others are not. As in much of the political ecology literature, this distinction also recognizes that neither starkly materialist, nor wholly constructivist analyses are satisfactory in making sense of complex socio-ecological processes that produce uneven flood risk (Ranganathan 2015). Rather, material interests must be understood as intertwined with the social construction of knowledge, power, institutional character, and identity. The sections below discuss some of the ways that material interests and epistemological factors have contributed to the continued proliferation of levees and associated infrastructures.

The role of powerful actors with vested material interests in conventional flood infrastructure mega-projects is well-documented. As discussed in Chapters 2 and 3, levee and pump-based urbanization produces opportunities for many different types of actors to profit. As Huq et al note in explaining the continued popularity of flood protection mega-projects, "building over-expensive and often ill-considered defenses can generate very large profits" (Huq et al. 2007). Groups who have direct and indirect material interests in the construction of conventional levee mega-projects in Dhaka and New Orleans include: public officials including those in hydraulic bureaucracies; private contractors, consultants, and builders; property owners and developers; and financial institutions including international development banks. Speaking of the eastern Dhaka embankment project, a Bangladeshi planner reported that, though there was widespread skepticism surrounding the project, it was likely to proceed because,

> The mega-project incentives are very high. Local contractors, bureaucrats, political leaders, funding agencies... they all have an interest in these mega-projects. This embankment has estimated cost of 11,000 crore taka [approximately $1.3 billion USD]... this is the estimated cost. The actual cost will be double or triple. So some local contractors will get the big contracts, the ADB will give loan, the brokers will give some bribes. (N. K. Rahman 2017)

Conventional mega-projects directly benefit the hydraulic bureaucracies or hydrocracies (e.g., the BWDB in Bangladesh and the USACE in the US) who are responsible for overseeing the design, construction, and operation of levees and pumps, increasing their budgets, staffing, and prestige (Molle, Mollinga, and Wester 2009). Such projects can also materially benefit bureaucrats and political officials by giving them the "capability to allocate public resources on a preferential basis" (Hughes, Adnan, and Dalal-Clayton 1994). A Bangladeshi water expert described this pro-mega-project bias in the engineering bureaucracies, saying,

> The bureaucrats and technocrats are eager to grab any big project they can. They are poorly paid... and these projects offer many opportunities to pad their earnings ... legally and illegally. Legally, they can go abroad for training. They can get new project cars, these sorts of things. And of course, illegally, there are no bounds. And so they are not interested in going into great depth on the merits of the projects... They just eagerly sign on. (Islam 2017)

This pattern of mega-project linked corruption is well documented and widely discussed in the context of Bangladesh and other developing countries (Soz, Kryspin-Watson, and Stanton-Geddes 2016), but levee construction has also long been associated with political corruption in New Orleans and south Louisiana (Austin 2006; Conaway 1973; Jeansonne 2006).

Conventional flood infrastructure mega-projects also benefit a huge network of private contractors, consultants, and construction firms. Several participants in the Changing Course competition discussed the distorting impact of the profit-motive in pushing mega-project approaches in the hopes that the competition would generate future contracts for the firms involved. This dynamic was exacerbated by an unexpected reduction in funding for the project teams from the competition organizers. With a dearth of funding from the organizers, members of two of the final three teams reported that the large engineering firms on the teams covered many costs and thereby gained disproportionate influence over their final outcome. A designer on one of the three final teams said,

> [The lead engineering firm] set up the team. They had the capacity. They paid for production and all this stuff. Everyone knew that it would cost more than the competition was putting in... They covered extra costs in the hopes of getting work out of it.

As a result, they reported that even though the team "had some heavy hitters" from landscape architecture and ecological sciences, "it was really the engineers in the lead. They would just say, 'Hey guys, here's what we're going to do." A Dutch engineer who participated in another team reported a similar pattern wherein a large engineering firm on the team used their relative economic and political power to promote what he called "a big engineering approach," because they were "very interested in being part of the implementation of the proposals eventually."

Flood control mega-projects materially benefit property owners and developers by raising the value of land by expanding the area available for urban and suburban development. The linkage between dry city infrastructures and real estate development in both New Orleans and Dhaka is discussed at length in Chapter 2 and 3. Baxter draws on Marx and Harvey to explain the leveeing and draining of eastern New Orleans as an example of rent-seeking, wherein private real estate speculators benefit from public investments in environmental transformation (Baxter 2014).

Finally, conventional flood infrastructure mega-projects can benefit financial institutions and bond holders. In the case of Dhaka, conventional flood mega-projects benefit international development lending institutions like the World Bank, ADB, and Chinese-government affiliated lenders by providing projects that can consume large consolidated loans to state actors. Speaking of the preference of international lenders for large flood protection projects, one Dhaka planner said,

> The funding agencies want big civil projects. They like structural measures. The ADB is a bank. If [we] propose this nature-based strategy that costs $1 million dollars they will not be interested. This is not worth sending a loan officer out three or four times. They want $4, 5, 6 million [projects].

He went on to say of this mega-project bias, "everything is focused on how it will help the investors and the companies." Speaking specifically of how the interests of international lenders pushed the BDP to embrace a mega-project approach in contradiction of the stated aims of the broader project, a Bangladeshi planner who worked on the BDP reported that the government pushed for large-scale engineering projects "to use the money from big parties" like "the World Bank and Japan" so that that money would "not go to some other country." They went on to say that the World Bank "tried to shift us to work in the way they want to, the way that will suit them best... they are in favor of big infrastructure projects that can be implemented soon."

Conventional dry city mega-projects remain popular among a broad range of actors who have material interests in the finance, design, construction, and operations of these projects and the urban and suburban expansions that they enable. The material interests of these actors both separately and in networked relationships create strongly path-dependent dynamics, which have become entrenched over many decades of infrastructural modernization in both Dhaka and New Orleans. It is also important to recognize that unlike the model of the local pro-growth coalitions featured in the 'growth machine' model (Logan and Molotch 1987), in this case the institutions and actors with material interests in promoting contemporary flood control mega-projects are frequently spatially dispersed, including actors at the national and international scale.

Counting Alligators: The Legibility Project at the Heart of Contemporary Flood Planning

Entrenched material interests explain some, but not all, of the reasons why levees and other conventional flood mega-projects continue to be popular even in the face of mounting critiques and calls for alternatives. Broadly speaking, what Nazrul Islam labeled the "epistemological" elements of levee path-dependence include a range of issues related to how the producers (e.g., hydrocracies and politicians) and consumers (e.g., residents and developers) of flood infrastructure mega-projects perceive, measure, and represent risk and security. James Scott has persuasively argued that, for centuries, states have develop and deploy abstract, simplified, and frequently quantitative measures to enact an "administrative ordering of nature and society" (Scott 1998). In Scott's framing, this "high modernist" approach is meant to make complex social and natural systems more "legible" to state institutions. Over time, these legibility projects transform the real world to more closely resemble the simplified administrative understanding of the world. Viewing dry city infrastructures in Dhaka and New Orleans as high modernist legibility projects reveals the linkages between the radical epistemological simplification that renders the socio-natural complexity of these places legible and the heavy-handed engineering interventions that seek to make the delta landscapes and the cities more closely resemble their simplified images. While Scott largely discusses state mobilizations of strategic abstraction to control and appropriate material abundance and human resources, the dry city infrastructures are more closely linked with the uneven distribution of risk, which Ulrich Beck identifies as a central concern of the emerging "risk society" (Beck 1992).

In both Dhaka and New Orleans, civil and environmental engineers dominate the hydraulic bureaucracies responsible for managing urban water and flood risk. The professional orientations and identities of these institutions remain firmly rooted in a mission to fortify urban space against the threat of hostile outside water and remove rainwater as quickly and efficiently as possible. The primary entities responsible for the design and construction of levees in Dhaka and New Orleans are both national

agencies, the BWDB and the USACE respectively. The logos of both institutions reflect their embrace of structural fortification as a core part of their mission and identity, a crenelated castle in the case of the USACE and a dam in the case of the BWDB (Figure 5.10).

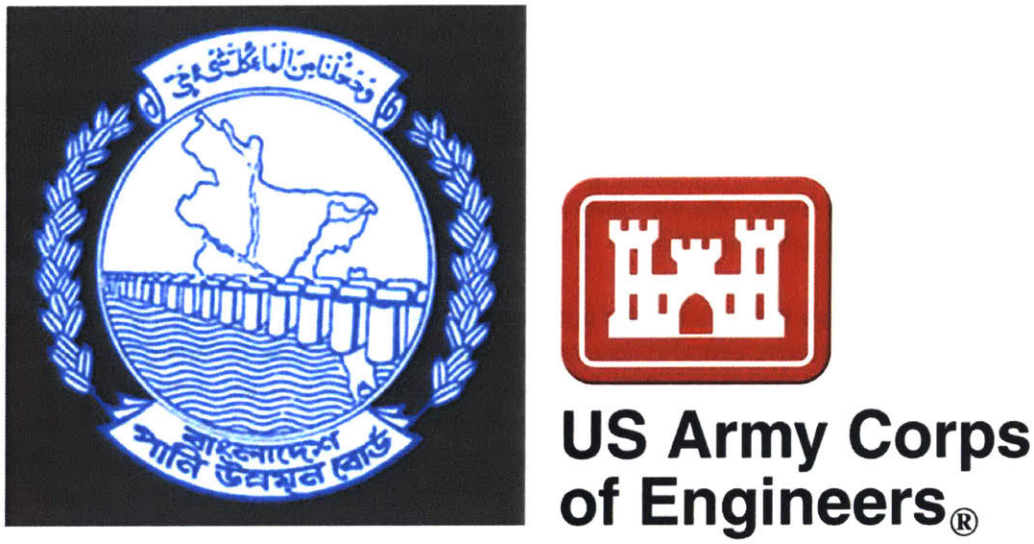

Figure 5.10. The logos for both the BWDB (left) and the USACE (right) reflect these institutions' deep commitment to infrastructural modernization prioritizing engineered fortifications.

These hydrocracy institutions conceptualize hydrology and flood risk in ways that are abstract, quantified, and largely detached from the dynamism of delta landscapes and the place-specific and historically-contingent dynamics of urbanization. As Mathur and Da Cunha have documented in both the Mississippi Delta (Mathur and Da Cunha 2001) and the Bengal Delta (Da Cunha forthcoming), this abstract approach to water engineering, with its affinity for clear boundaries, is in conflict with the dynamism of delta landscapes where water and land are in constant flux. These hydrocracy institutions have been tasked with constructing and maintaining this uneasy spatial distinction between land and water, city and swamp. Even in the face of mounting evidence of dangers and unintended consequences, levees and pumps remain their preferred tools for constructing and maintaining this binary separation.

Though recent flood planning efforts in both the Bengal and Mississippi deltas embrace the rhetoric of long-term holistic planning, in both cases they have continued to rely on simplistic project-by-project analysis. Advocates celebrate the Louisiana Coastal Master Plan's rational modeling and "quantitative comparison of options for action" (CPRA 2017). Critics see the CPRA's project-based approach as lacking a coherent vision and as insufficiently ambitious in its attempts to reshape the coast. In the words of one local designer and planner, the CMP "isn't a master plan" at all, rather "it is a prioritization of projects based on modeling." Another observer spoke to the limitations of the project-based approach saying,

> The Master Plan was really a set of projects. Where do they come from? Well, they were really just a collection of physical projects that were kind of laying around all over the place. In 2007, they said "bring me your projects." RAND was leading on this and they created what they still call "The Planning Tool" to help assess and prioritize projects... So they poured 300 some projects into the Tool and 100 came back as "the best." (Cochran 2017)

Speaking on the limits of this quantitative, project-based approach, they went on to say,

> They tried to quantify everything... but that just didn't work. How are you going to tell a community that you can't do their project because [the model indicates that] it doesn't have enough alligators?

The CMP's abstract project-based modeling approach has led local planners to described the CPRA as "a very science and engineering focused organization" (Hill 2017), "a kind of big engineering firm"(Cochran 2017), and "hyper-rational" (Chang 2017a). Critics regard this approach as insufficient to the challenge facing the coast because it does not include "thinking about big picture alternatives" (Carney 2017).

Thought the Bangladesh Delta Plan was started with the promise of providing a plan for 'holistic and integrated' 'adaptive delta management,' this effort too evolved to become a project-based modeling and evaluation exercise. A Dutch designer who worked on the BDP investment plan used language that was strikingly similar to descriptions of the Louisiana CMP in saying that the BDP's projects were selected for investment from "a pile of 200 projects that all the various agencies and ministries related to water resources provided" (de Kort 2016). In spite of the BDP's rhetoric of holism and integrated analysis, several participants in the project reported that the process had become a state simplification project focused on GDP growth. One Bangladeshi planner reported that the current government's "goal of getting to middle income country status by 2021" was a major driver, saying,

> The government thinks this Delta Plan will lead to more big projects, which will lead to more employment and more economic activity and to higher GDP.

Another senior planner made a similar point saying that the General Economic Division, the section of the Government of Bangladesh that is responsible for generating the country's 5-year plans and was also responsible for the BDP, "only think of GDP."

The entities responsible for managing water in Dhaka and New Orleans continue to view the deltas and cities as a collection of quantifiable and spatially differentiated phenomena, including: cubic meters of water flow per second, probabilistic estimates of the return period of various hydrologic events (e.g., 100-year storms), base flood elevations, probabilities of infrastructure failures, and acres of land made available for agricultural or urban settlement. Each of these measures are elements of calculating both risk and value. Together they serve as the basis for insurance premiums and land values. Dry city infrastructures like levees continue to be popular among state actors because they offer the promise of simplifying and domesticating unruly delta landscapes, separating the territory into discrete zones whose physical attributes and risk characteristics can be easily modeled and manipulated to produce desired changes in development.

"A Comprehensive Plan is More Difficult to See": Levees and the Politics of Visibility

Some of the enduring appeal of levees and other mega-projects resides in their character as tangible, visible, and symbolically powerful artifacts of state action. Scholars have long recognized the political potency of water infrastructure mega-projects as symbols of modernization around the world, including in Greece (Kaika 2006), France (Gandy 1999b; Mukerji 2007), the American West (Worster 1985), Pakistan (Mustafa 2005), and Vietnam (Benedikter 2014). Benedikter describes the politics of water mega-projects saying,

> Politicians increasingly capitalised on the symbolic value of state-sponsored mega projects in order to legitimise themselves as the creators of progress and modernity. (Benedikter 2014)

The political imperative to take visible action was a central part of the appeal of dry city mega-projects in the 20th century era of infrastructural modernization. It remains so today. In their influential 1964 water infrastructure master plan for East Pakistan, IECO explicitly acknowledged that the "economic and political stability and contentment of the people" were among the major goals of their proposed mega-projects (EPWAPDA and IECO 1964).

The political potency of flood mega-projects is even more pronounced in the immediate aftermath of a flood event. Following consecutive years of major flooding in the late 1980s, Bangladesh's military ruler Mohamed Ershad invoked national stability in calling for a "permanent solution" to the flooding challenges, saying "the nation could not accept such a situation any more" (*Bangladesh Observer* 1988d). The authors of the American *Eastern Waters Study,* which argued against flood control mega-projects for the Bengal delta, recognized that the political climate of the country dictated that "vigorous and visible steps by the government against the flood danger are essential to the political, and even the deeper social, stability of the country" (Rogers, Lydon, and Seckler 1989). Scholars have recognized a similar bias towards state investment in discrete, visible, and politically symbolic projects as a driver of levee construction in New Orleans (Burby 2006). In reassuring New Orleans' residents that "our first priority is the levees," Joe Canizaro, the chairman of the post-Katrina Bring New Orleans Back Commission, was similarly drawing on the political efficacy of levees in demonstrating timely and decisive action (Meitdrodt and Donze 2005).

Their material and spatial presence also make levees, pumps, and flood walls photogenic backdrops against which political actors can pose, showing their concern in times of crisis and demonstrating leadership following new investments. During the late 1980s floods in Dhaka, the city's daily newspapers carried numerous photographs of both Ershad and the political opposition leaders standing on the DND embankments south of the center city. Similarly, the completion of each component of the post-Katina Hurricane & Storm Damage Risk Reduction System provided an opportunity for press conferences and photo opportunities for USACE officials and political leaders to show that they were taking action to fortify the city (Figure 5.11). Recognizing the role that visibility and political symbolism plays in the enduring appeal of structural flood protections, one Dutch landscape architect who has worked extensively in New Orleans said, "a comprehensive plan is more difficult to see" (Koole 2016).

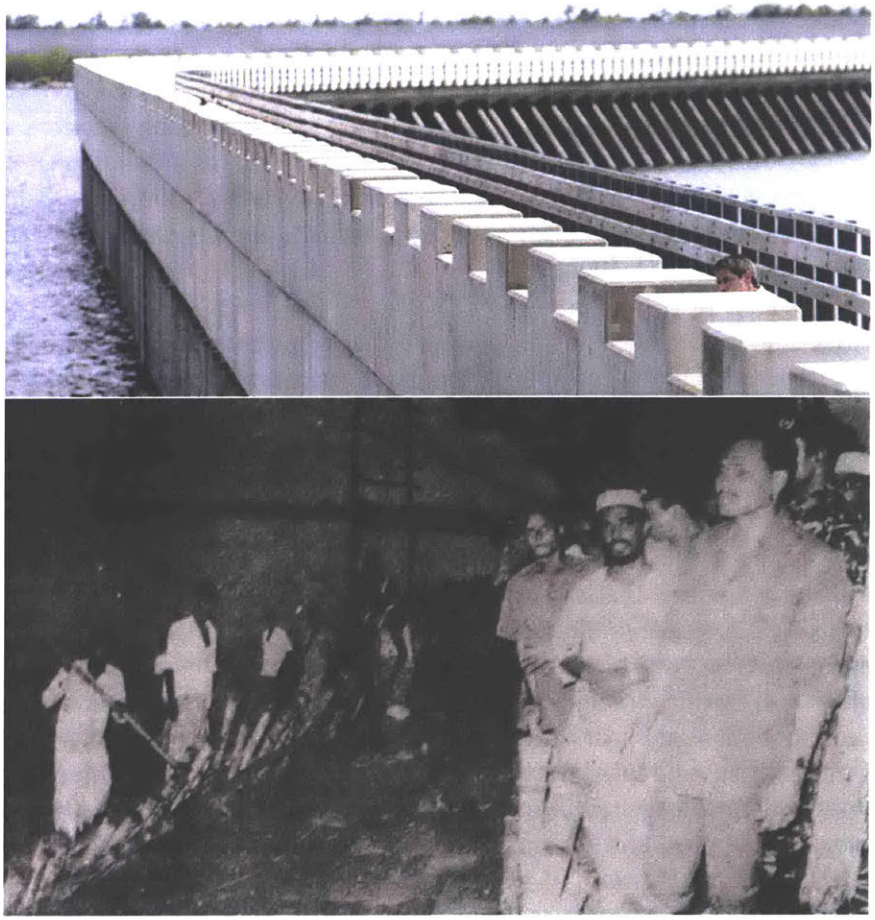

Figure 5.11. Dry city infrastructures as political stage sets. Top: Senator David Vitter at an opening ceremony for the post-Katrina Lake Borgne Surge Barrier (*Times-Picayune*). Bottom: Mohamed Ershad visits the DND embankments south of Dhaka during the 1988 floods (*Bangladesh Observer*).

Levees and other flood mega-projects provide politically potent symbols of state efficacy in securing people and property and in improving abstract quantitative measures of development and growth like GDP. These dynamics privilege interventions whose impacts can be clearly seen, quantified, modeled. In the process, they ignore or damage forms of social and natural organization that are less legible, often deepening pre-existing socio-economic inequalities. In both Dhaka and New Orleans, critics of hydrocracy institutions highlighted the detachment of these institutions from embedded knowledge and local experience. One Dhaka planner spoke to this concern, saying

> What was the problem with the engineers? It is not that they are bad people. It is not that they didn't want to do something good for the people. It is that we have only one tool, our knowledge. (N. K. Rahman 2017)

In the midst of the fierce debates surrounding the Bangladesh Flood Action Plan (FAP) in the early 1990s, critics spoke out against proposed embankments and other water engineering interventions (Rogers, Lydon, and Seckler 1989; Adnan and Ghani 1991). While planning models showed that the FAP projects, including Dhaka's embankments, achieved positive cost-benefit ratios and GDP growth targets by enabling more intensive agricultural and urban development, critics argued that these models were incapable of seeing many of values of the pre-existing landscape systems. Adnan argued that unembanked delta landscapes hosted a complex array of interwoven and temporally-dynamic common

pool resources, including seasonal fisheries and grazing lands. Because FAP project planners could not understand or model many of these commons, their projects threatened to destroy them, devastating poor commons-dependent rural communities in the process (Adnan and Ghani 1991). While levees and other forms of infrastructural modernization often have powerful impacts on resource distribution, the abstract and simplified epistemology underlying these projects obscures distributional politics. Timothy Mitchell recognized this dynamic as part of a "rule of experts" (Mitchell 2002) and James Ferguson describes the impacts of such abstract epistemologies as constituting "anti-politics machines" of techno-managerial development (Ferguson 1994).

Structural flood protections and mechanical drainage projects continue to proliferate in Dhaka and New Orleans even in the face of mounting criticisms of these strategies because the material interests and entrenched simplifying epistemologies that support these strategies persist. While it is useful to articulate the material interests and epistemological factors, it is also critical to recognize that these two categories are far from wholly distinct. Rather, they are deeply intertwined and co-constitutive. Simplified modes of seeing, analyzing, and representing the natural and social dynamics of these cities and their delta landscapes enable heavy-handed mega-project interventions by selectively valuing certain forms of resource use and spatial transformation and devaluing or rendering invisible those forms which are less legible. These modes of seeing and knowing natural and social systems are directly linked to the material interests and professional identities of a wide array of powerful interests, from politicians and officials in state hydrocracy institutions, to private contractors and lands speculators. For the purposes of cost-benefit analysis or GDP calculations, the profits gleaned by filling and selling eastern Dhaka's wetlands as residential development plots can be readily calculated. In contrast, the livelihoods that longtime residents create from farming, grazing, and fishing these lands, many of which are held in complex, overlapping, and dynamic commons relations, are largely invisible to abstract modes of measurement and evaluation. Likewise, the many other landscape values of these wetlands, from flood mitigation and water filtration to urban heat island mitigation and aesthetic, recreational, and cultural values are largely illegible to technical models and state economic planning. And so, even as planning processes claim to bring new paradigms of holistic analysis, long-term vision, and nature-based intervention, the underlying linked epistemological and material interests that powered the golden age of infrastructural modernization persist.

Eco-Infrastructural Modernization

> The response to failures of modern water management systems has not been to draw upon traditional knowledge systems and enhance local capability, but rather to introduce newer structural measures which involve even greater dependency on external technology and expertise. (Hughes, Adnan, and Dalal-Clayton 1994)

In the early 1990s, critics of the Flood Action Plan responded with outrage to proposals to dramatically increase the engineered control of Bangladesh's delta landscape. The groups behind the FAP largely responded to the failures of previous flood control mega-projects by doubling down on familiar strategies, rather than rethinking their underlying logic. In many cases, this same criticism is applicable to the current generation of water management mega-projects under consideration in both the Bengal and Mississippi deltas today. Even as dry city infrastructure mega-projects are increasingly the target of criticism, the new projects suggested to replace them often call for more, rather than less, engineered techno-managerial control.

Many contemporary Dutch-inspired water planning projects in Dhaka, New Orleans and elsewhere, are presented as atoning for the sin of urban infrastructural modernization, seeking to rebalance an unhealthy relationship between city and nature. As the 2015 *Resilient New Orleans Strategy* puts it, "We must align our infrastructure and urban environment with the realities of our delta soils and geography... rather than resist water, we must learn to embrace it" (City of New Orleans 2015). This conciliatory framing suggests a mode of infrastructural and urban development that surrenders some degree of control and reconnects urban landscapes to the hydraulic dynamics of the surrounding landscape. As previous sections have shown, there is little sign that conventional dry city infrastructures will be dismantled or substantially changed in either Dhaka or New Orleans. Even recent projects that break with conventional dry city practices nonetheless recreate the unwise and unjust dynamics of the mega-projects of past generations. They are marked by the same entrenched material interests and abstract epistemologies of the past and therefore, they continue to extend engineered control over volatile delta landscapes.

Like the infrastructural modernization promoted by the mid-20th century 'Ambassadors with Bulldozers,' many ambitious contemporary flood mitigation projects promise wholesale social and economic transformation through water infrastructure modernization. While some of these new projects do address particular critiques of earlier dry city mega-projects, people who have worked closely on these projects point towards a need for deeper change. As discussed above, recent water management planning efforts in Dhaka and New Orleans, like the Coastal Master Plan and the BDP 2100 display a problematic tendency towards a simplifying techno-managerialism.

The Changing Course competition was partially born out of frustration with the conservatism of the Louisiana Coastal Master Plan. One competition organizer told me that they were especially interested in the bringing the "opportunistic and even positive" orientation of the Dutch 'living with water' approach to New Orleans and the lower Mississippi Delta (Cochran 2017). And so, the organizers and team leaders aggressively courted high profile Dutch water experts to participate in the competition. While the CC competition was initiated to bring "out-of-the-box" visionary thinking to planning the long-term viability of the lower Mississippi and the south Louisiana coast, several participants and observers lamented that this effort too ended up being dominated by the epistemological and professional constraints of what one participant called "a big engineering approach." Though there was nominally no coordination between the three finalists, all three teams ended up developing similar schemes. In each case, the teams proposed a combination of: building new sediment diversion structures in the Mississippi River levees to allow river sediments to build land in the delta; shortening the length of the river's levees and navigation channel; and abandoning and relocating some settlements, infrastructure, and navigation routes of the lower delta. In one of the CC team's final presentation materials, these sediment diversion structures are symbolized with a series of cartoon faucets that could be opened and closed "to distribute sediment across the delta" (Figure 5.12).[8]

[8] Many of the proposals generated by the Coastal Master Plan and the Changing Course competition are reminiscent of earlier visionary multi-disciplinary proposals for coastal restoration and delta preservation developed by a Louisiana-based firm, Coastal Environments, in the 1970s (Gagliano 1973).

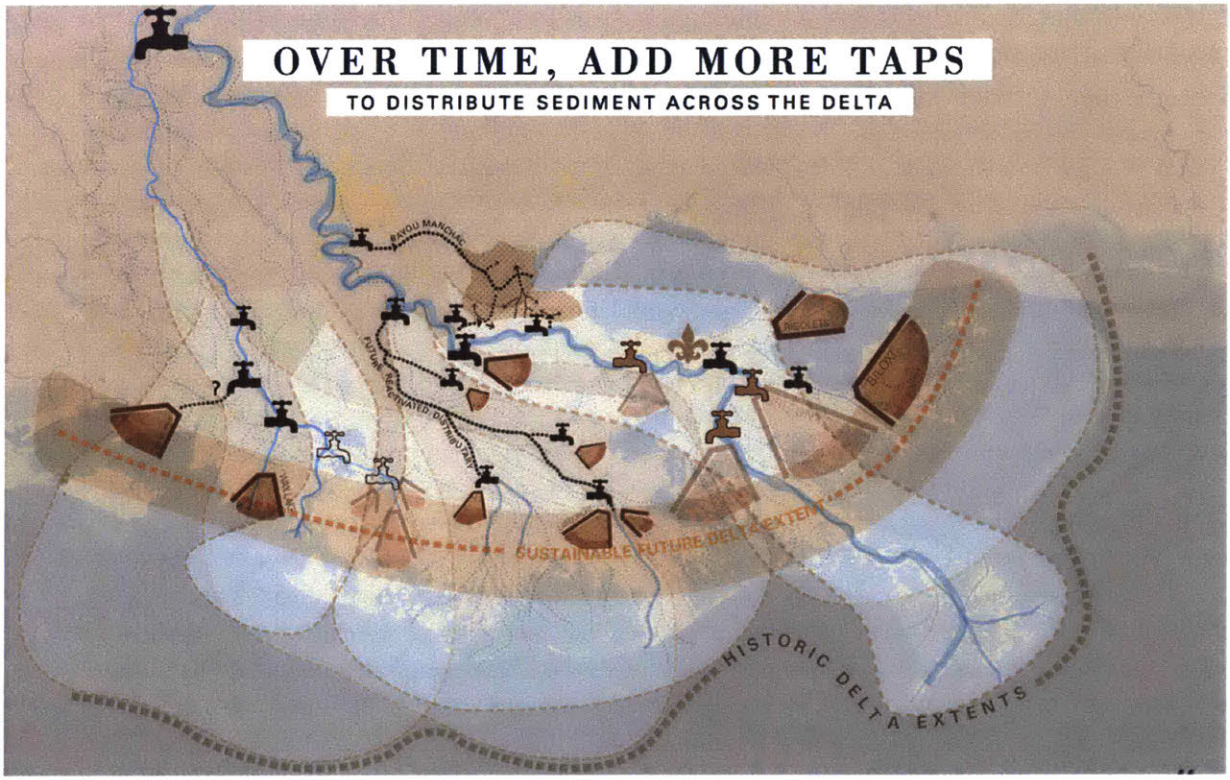

Figure 5.12. Re-plumbing the delta. Sediment diversion control structures proposed by Changing Course finalists would bring on more, rather than less, landscape control. (Baird Team 2015)

Many observers and participants remarked that, even as they promised to fundamentally rethink the nature of life in the delta, the CC proposals would bring more engineered control over the hydraulic regimes of the delta rather than less. A designer on one of the final teams complained that their proposal "ended up as a positivist ecological engineering project," not fundamentally rethinking human settlement in the delta, but simply adding and tweaking engineered control structures.

Some of the more ambitious proposals in the BDP 2100 similarly reflect a drive to increase, rather than decreasing engineered control over the delta's waters. While many of the BDP's recommended projects are drawn from pre-existing conventional mega-project proposals, the plan also includes a selection of "out-of-the-box and inspiring ideas" that it identifies as "iconic projects for 'Optimized Water Control'" (Bangladesh Planning Commission 2017). The visionary project that is most relevant to Dhaka's flood mitigation future is a proposal described as,

> Reclamation of a large flood-free area named 'New Dhaka' by the Padma River to accommodate a new airport and a business district as well as governmental offices, with high-speed rail connections to 'Old Dhaka' thus creating opportunities in Old Dhaka to create public open space suitable for temporary water storage (Bangladesh Planning Commission 2017).

This proposal for a "New Dhaka" and the "Jamuna Pearl," another urbanization proposal in the BDP (Figure 5.13), both represent major land reclamation mega-projects. As critics in Dhaka told me, these projects are hardly built on the new more conciliatory Dutch "living with water" approach. Rather, they extend and amplify engineered control in ways that would massively benefit domestic hydrocracies, foreign consultants, and the Dutch dredging firms that are among the prime backers of the BDP and the aggressive international marketing of Dutch water expertise more generally (Bergh, Bucx, and Guchte 2012; de Vriend and van Koningsveld 2012).

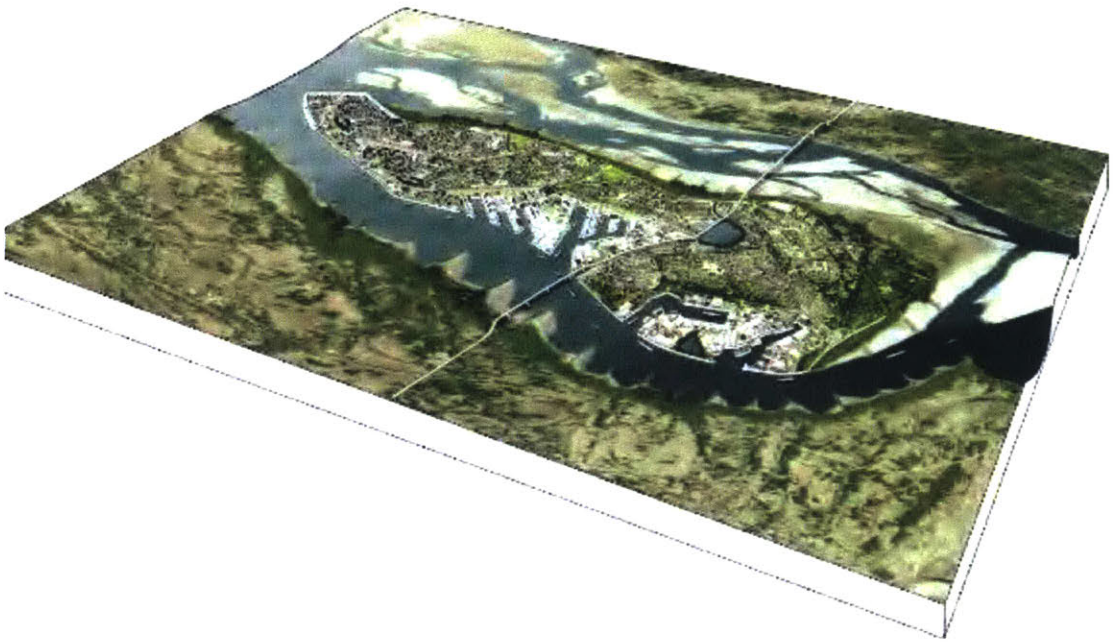

Figure 5.13. The "Jamuna Pearl" from the BDP 2100 proposes a new mode of urbanization enabled by a combination of structural protection and land reclamation.

Contemporary projects promising a new paradigm of water management invoke the dual crises of climate change and urban change as new uncertainties and complexities demanding new scales and types of integration and adaptive planning. While these projects, with their new strategies and retooled rhetoric and representations, may address some of the problems of previous generations of mega-projects, they largely leave intact the entrenched epistemologies and 'big engineering' material interest that created the problems of the past.

Though advocates present these new strategies as decisively breaking with the models of 20th century infrastructural modernization, in many cases they are ushering in an era of *eco-infrastructural modernization,* founded in the same flawed logic and likely to reproduce parallel patterns of damage in social and natural systems. This emerging eco-infrastructural modernization combines elements of the (1) 'Promethean project' of infrastructural modernization (Kaika 2004) and (2) "ecological modernization" (Gandy 1999a). Understood as Promethean modernization projects, 20th century dry city infrastructures were a part of a larger process of rendering the city independent of the dangers and dynamism of natural landscape processes by erecting physical and hydraulic barriers distinguishing and separating 'city' from 'nature'. "Ecological modernization" is the attempt to resolve the environmental crises brought on by modernization with further modernization. Matthew Gandy describes this process as "seek[ing] to convert ethical and political dilemmas into technical and managerial problems." Gandy's framing of ecological modernization as "replacing earlier forms of technical neutrality with new forms of techno-managerial control," describes quite precisely the ongoing efforts to address the problems of dry city infrastructural modernization with new and more pervasive forms of landscape control (Gandy 1999a).

The Unjust Processes and Impacts of Remaking Urban Water Management

Water management mega-projects undertaken in the name of climate adaptation may, like their predecessors, lead to myriad unintended environmental and social impacts. Many of these concerns

relate to the distributional and equity implications of urban climate adaptation (Sovacool, Linnér, and Goodsite 2015). Climate adaptation projects, like previous generations of infrastructural development, may be unjust in both their processes and their outcomes. Through both "acts of commission" and "acts of omission," adaptation can deepen existing socio-economic disparities (Anguelovski et al. 2016b). Hodson and Marvin have raised alarms that "secure urbanism and resilient infrastructure" developed in the name of climate adaptation may exacerbate inequality by creating "premium ecological enclaves" (Hodson and Marvin 2010b, 2010a).

In both Dhaka and New Orleans, some efforts to reform urban water management have had deeply unjust implications. As discussed above, the popular resistance to both the post-Katrina Green Dot Map proposal in New Orleans and to some coastal restoration efforts outside of New Orleans levees were driven by the perception that these efforts would repeat past patterns of uneven planning impacts, disproportionately harming urban African-American neighborhoods in one case and rural settlements in the other. Both of these cases indicate that, while there is growing agreement that previous mega-projects were damaging, ill-informed, and often unjust, shifting away from conventional dry city strategies will likely create another set of conflicts and complications. As Lewis and Ernston have observed regarding contemporary coastal planning in south Louisiana,

> It is possible to appreciate the novelty and utility of hybrid and ecosystem-based infrastructure, while not de-emphasizing the deeply contested character of these coastal land and waterscapes. (J. A. Lewis and Ernstson 2017)

Recent water management infrastructure projects in Dhaka have raised similar concerns, that the urgent threat of urban flooding may be used to justify major restructuring that disproportionately harms the least advantaged urban residents. Perhaps the most dramatic instance of the unjust implications of progressive urban water management projects in Dhaka's recent history is the case of the Hatirjheel. The Hatirjheel project is a rare example of a fully realized complex, large-scale, multi-purpose infrastructure project in Dhaka. Like the "Green Dot Map" proposal and other green infrastructure projects in New Orleans, the Hatirjheel was primarily conceived as a means of 'internal softening' to allow the area inside Dhaka's western embankments to retain stormwater more effectively. The project includes 300 acres of stormwater ponds to temporarily accommodate runoff from 30 square kilometers of central Dhaka. The project also includes new public spaces and investments in adjacent roads and bridges to alleviate Dhaka's notorious traffic congestion. The Hatirjheel project was first proposed after heavy flooding beset the capital for more than two months in 1998. It enlisted the efforts of experts from among Bangladesh's top academic institutions (BUET) as well as resources from several government ministries and agencies, including RAJUK and the Army.

Since it was inaugurated in 2013, the Hatirjheel has become widely celebrated and emulated. As one RAJUK planning official reported, "every town wants to build their own Hatirjheel now" (Chaudhury 2017). Iqbal Habib, the architect whose firm was responsible for the urban design of the project, describes it as transforming "wasteland into water land" and celebrating a "hydroecological asset of the city" (TEDx Talks 2015). In an interview, Habib described the project as an inflection point in the "revival" of "water urbanism" in Bangladesh (Habib 2017). He regards the project as a return to a model of the "mound and pond" settlement, which was "the concept of the whole of Bangladesh" before the "cordon approach" of dry city infrastructural modernization (Habib 2017).

Though the Hatirjheel project has been widely celebrated, the project also draws criticism from several sides. Drainage engineers argue that their vision for the project's function was compromised by the demands of designers for more walkways and public space (Khan 2017). Designers complain that the

project is a placeless "fragment of Singapore in the middle of Dhaka" (Ashraf 2017a) and lament that what started as an "urban design project" was taken over by civil engineers as a drainage project (S. Ahmed 2017). Both designers and drainage engineers complain that the project was hijacked by traffic engineers.

While these offsetting complaints might be seen as a sign of a successful compromise, critics have also raised alarms about the undemocratic process by which the project was realized and its troubling equity implications. Several interviewees indicated that the Hatirjheel project was only able to be realized because the "caretaker government," the technocratic unelected government that was in power when the project was initiated, ignored public opinion and the legal mandates of standard contracting and tendering processes. The fact that the Army was the primary entity responsible for the Hatirjheel's construction also raised alarms for some observers. One leading project actor told me,

> The caretaker government was very forceful to bring in different agencies. And because the caretaker government was backed by the army, no one was very critical.

Some observers were concerned that the undemocratic process contributed to unjust outcomes such as the displacement of thousands of landless informal settlement residents with no compensation or rehousing. Dhaka's planning authority, RAJUK, built two high-rise apartment buildings to provide compensation housing for people displaced by the Hatirjheel project. However, the towers contain only 112 flats (Mahmud 2013) while estimates of the number of people displaced by the project run in the tens or even hundreds of thousands (Hossain 2013). Flats in the RAJUK buildings were reserved for those who could prove their ownership of land in the impacted area. Renters and those who could not prove legal tenure were simply displaced with no compensation or assistance.

The displacement of poor people from the Hatirjheel site is particularly troubling given that more economically and politically powerful interests have been allowed to stay in the area illegally for over a decade. In 2006, the Bangladesh Garment Manufacturers and Exporters Association (BGMEA), the group representing one of the most powerful industries in the country, built their headquarters on land in the middle of the Hatirjheel project area (Figure 5.14).

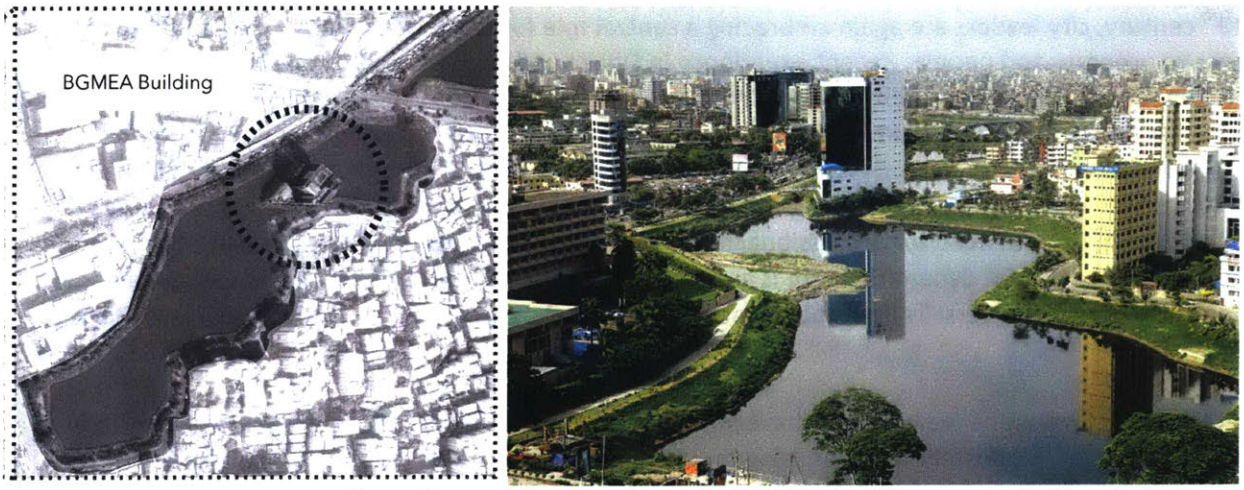

Figure 5.14. Uneven impacts from the Hatirjheel project. The BGMEA building was built illegally in the wetlands. While informal settlements were displaced without resettlement assistance or compensation, the BGMEA, a powerful industry group, has continued to occupy their illegally developed office building on the site for more than a decade. Left: Google Earth. Right: *Daily Star*.

Though the project had been in planning for nearly a decade at the time, the powerful industry group was able to fill the land and construct a 15-story office building. In spite of the BGMEA project's illegal location, the former prime minister presided over the building's groundbreaking and the current prime minister presided over its dedication when it was completed. The building has become a symbol of Dhaka's ineffective spatial governance and the ability of powerful interests to subvert environmental and land use rules for their own benefit. Since it was completed, the building has been the subject of a public legal battle. While recent rulings from the Bangladesh High Court found that the BGMEA must vacate and demolish the building, the building still stands many years after poor residents were summarily cleared from the site ("Fate of Illegal BGMEA Building Sealed" 2017, "BGMEA Gets One Year More to Demolish Building" 2018).

The Hatirjheel project undoubtedly demonstrates a new model for integrated water infrastructure planning in Dhaka, combining spatial planning and urban design with civil engineering to bring multi-functional benefits. However, its undemocratic technocratic process make it largely unreplicable under normal conditions in Bangladesh. The approach also led to a radically uneven distribution of costs and benefits in which some of the city's poorest and most vulnerable residents were displaced, powerful interest groups where allowed to stay, and some of the project's benefits (e.g., traffic alleviation) are largely enjoyed by well-off residents. As was the case with other recent waterway restoration projects in the Dhanmondi, Gulshan, and Banani neighborhoods, the Hatirjheel project is already increasing property values and development activity in the area. While project designer Iqbal Habib describes these "water urbanism" projects as a matter of universal "urban survival," their benefits disproportionately flow to the well-off residents of the posh neighborhoods surrounding the existing lakes (Habib 2017) Though these projects do demonstrate alternative strategies for coping with Dhaka's urban water management problems, they also have deeply unjust implications, driving uneven displacement and "green gentrification" through the creation of "premium ecological enclaves" (Hodson and Marvin 2010a).

Conclusion

After decades of mounting skepticism and critiques of the dry city infrastructure mega-projects of the 20th century, city leaders are again embracing a central role for state institutions in reducing flooding risks to property and people. Recent experience in Dhaka and New Orleans suggests, that while this new generation of projects may address some of the problems of the past, there is also cause for concern. By focusing on the geophysical similarities between 'delta cities,' Dutch water management experts have made the case that strategies developed in the Netherlands are transferrable to radically different settings like Dhaka and New Orleans. Even as many of the people involved in these contemporary efforts recognize the need for professional humility, caution, and attention to place-specific and historically contingent dynamics, there is great pressure to "market the Dutch approach" as "a generic approach" and a "universally applicable methodology for climate proofing" (Bergh, Bucx, and Guchte 2012).

The cases of Dhaka and New Orleans have shown that (1) once in place, dry city infrastructures are highly obdurate; (2) despite the promising rhetoric of a 'new paradigm,' conventional dry city infrastructure projects continue to proliferate, gaining new legitimacy and support from recent Dutch-influenced flood mitigation planning; and (3) even strategies that do depart substantially from the model of dry city mega-projects continue to be driven by path-dependent patterns linked to entrenched simplifying epistemologies and the 'big engineering' biases of powerful material interests.

Proposals like the "Green Dot Map" in New Orleans and the Hatirjheel stormwater lakes in Dhaka suggest that the shift from "vertical" to "horizontal," from "gray" to "green" infrastructure cannot be assumed to remedy the unjust and unwise patterns of past flood mitigation. Rather, these projects show that, without concerted attention to the equity impacts of major flood mitigation projects, the most vulnerable residents of cities are likely to bear a disproportionate cost of future adaptation. The next chapter considers how the growing role of visualization and other tools of spatial planning and design are contributing to changes in contemporary flood mitigation planning in Dhaka and New Orleans.

CHAPTER 6
Design and Flood Mitigation: Enabling Synthesis, Constraining Debate

Chapter Summary

Many contemporary urban flood mitigation projects enroll a broader range of expertise than did projects of the past. Where 20th century dry city infrastructural modernization projects were dominated by civil engineers and hydrologists, contemporary projects include many other disciplines, including the ecological and social sciences as well as designers and spatial planners. The increasing role of designers and spatial planners is especially pronounced in water and flood planning projects influenced by recent water management practices developed in the Netherlands (Kempenaar et al. 2016; Weisz, Blumberg, and Keenan 2015). In Dhaka and New Orleans, as in other flood-vulnerable cities, tools and methods from the design and spatial planning disciplines (e.g., urban design and landscape architecture) are increasingly central to projects addressing flood vulnerabilities and the perceived failures of previous generations of infrastructure. Where earlier flood control infrastructures have been criticized as unwise and unjust due to their unintended social and ecological impacts, contemporary projects promise a more holistic, integrated, and adaptable approach. Rather than 'vertical' strategies like levees and floodwalls, contemporary projects focus on 'horizontal' approaches to mitigating flood hazards, making space in the landscape to retain and infiltrate water (Warner 2008). This shift is variously described as moving from 'vertical' to 'horizontal', 'closed' to 'open', or 'gray' to 'green.' New projects are promoted as restoring a more harmonious relationship between urban settlements and natural landscape forces and functions. Designers and spatial planners are increasingly seen as central to these cross-disciplinary projects.

This chapter asks: what opportunities and challenges come with the increasingly prominent role of design and spatial planning in major water management infrastructure planning projects? The chapter presents analysis of proposals as well as insights from interviews with participants, experts, and critics involved in recent water management projects in Dhaka and New Orleans. It finds that there is broad agreement that design and spatial planning hold significant promise for improving both the process and communication of complex urban adaptation projects. However, there are considerable challenges to using the tools of design and spatial planning in these projects. While the 'sloppy thinking' and process visualization tools of design can lead to new syntheses and possibility, the efficacy of these tools is deeply tied to specific cultural values, and thus not readily transferable between geographic or professional settings. In the realm of communication, design visualization can be a powerful tool for communicating trade-offs of projects, displaying processes of change over time, and presenting synergies and opportunities for mutual benefit. However, design visualization can also hinder the critical processes of political contestation and debate that are necessary for inclusive and equitable adaptation. By ignoring, obscuring, or invoking urgency to bypass conflict, design visualizations can depoliticize flood mitigation and adaptation. This depoliticization can evacuate dissent and silence non-dominant voices, leading to adaptation projects that further entrench pre-existing socio-economic inequalities.

Introduction

Advocates present contemporary urban flood mitigation projects as a distinct break from the patterns and practices of the past. Whereas the 'Promethean projects' of 20th century dry city infrastructural modernization deployed structural barriers and mechanical drainage pumps to maintain a strict binary separation between wet and dry, swamp and city, contemporary projects are presented as more sensitive to socio-ecological complexity. Project advocates argue that, while dry city approaches were rigid and prone to catastrophic failure, this new paradigm of flood mitigation will deliver projects that are more adaptable in the face of dynamic landscape systems and the uncertainties of future climate change and urban conditions. Where 20th century dry city infrastructure planning was dominated by the logics and tools hydrological sciences and civil engineering, contemporary projects embrace a broader array of disciplinary knowledge.

Among the disciplines that are increasingly enrolled in urban water infrastructure and planning projects are the design and spatial planning professions, including landscape architecture and urban design.[9] Many of these design-centered efforts to remake urban water management in Dhaka, New Orleans, and elsewhere are influenced directly or indirectly by recent efforts in the Netherlands. Using conciliatory slogans like 'design with nature,' 'living with water,' and 'room for the river,' these Dutch-influenced practices promise to work with, rather than fighting against, the dynamics of low-lying and flood prone landscapes. To address the failings of dry city infrastructures and to prepare for the uncertainties of climate change, they promise to use design and spatial planning, along with science and engineering, to realign urban settlement patterns with underlying landscape functions. These new approaches to water management have been identified with a range of labels including: resilient urbanism, delta urbanism, adaptive urbanism, and green infrastructure. While projects enlisting design and spatial planning in remaking urban water management have been widely embraced by governments, philanthropies, academic researchers, and practitioners, many questions remain as to whether these efforts will address the critiques of previous generations of flood infrastructure or reproduce the unwise and unjust results of infrastructural modernization.

This chapter addresses the question: what opportunities and challenges come with the increasingly prominent role of design and spatial planning in urban flood infrastructure planning projects? It includes analysis from interviews and documents related to recent urban flood mitigation planning projects in Dhaka and New Orleans, with a particular focus on design-centered Dutch-influenced projects like the Changing Course competition for the lower Mississippi delta and the Bangladesh Delta Plan 2100. After briefly introducing some key concepts and debates, the chapter discusses three main findings. First, the design and spatial planning disciplines are indeed increasingly enrolled in complex multi-disciplinary projects to remake urban water management in Dhaka and New Orleans. Second, across a broad range of actors, there is widespread agreement that the tools of these disciplines hold promise for improving the processes, products, and communications of these efforts. Finally, employing the tools of design and spatial planning in ambitious flood mitigation and climate adaptation projects comes with some challenges and dangers. These tools can be used to ignore, obscure, and rush past necessary political contestation in order to promote potentially damaging spatial restructuring projects. Like the purportedly neutral techno-managerial methods used in the era of 20th century infrastructural

[9] Designers have worked at the intersection of water management and urban spatial planning and design for generations (e.g. Fredrick Law Olmsted's 'Emerald Necklace' in Boston and Ian McHarg's ecological planning for The Woodlands and elsewhere). Given this history, this contemporary moment marks a revival. As discussed in previous chapters, many of the contemporary proposals for realigning settlement patterns with landscape forces are reminiscent of earlier proposals like the early 1970s WMRT Pontchartrain New Town in Town proposal for eastern New Orleans (New Orleans East Inc. 1972) and the McHarg-influenced early 1980s DMAIUDP anti-levee plan for Dhaka (Shankland Cox Partnership 1981a).

modernization, the visualization tools of design and spatial planning can be used to evacuate dissent, enabling projects that threaten to deepen existing socio-economic disparities.

The Design-Politics of Revived Urban Mega-Projects

The imperative of adapting to climate change and the pressures of uneven urban development are driving a new generation of urban flood mitigation mega-projects in cities around the world, including in Dhaka and New Orleans. These new adaptation mega-projects are part of a larger resurgence of urban mega-projects after an era of state retrenchment (Altshuler and Luberoff 2003). Orueta and Fainstein observe that contemporary urban mega-projects overcome neoliberal state retrenchment and public suspicion after generations of heavy-handed mega-projects by "display[ing] a greater environmental sensitivity and commitment to urbanity than the modernist schemes of an earlier epoch" (Orueta and Fainstein 2008). Though the typical 21st century urban mega-projects have been public-private investments in cultural and consumption activities in historic, waterfront, and post-industrial landscapes, many recent urban flood infrastructure proposals display this same combination of environmental sensitivity and renewed focus on urbanism. Designers are increasingly contributing to large-scale regional environmental planning efforts (Kempenaar et al. 2016)[10]. In this current revival of regional-scale work focused on climate adaptation and urban and regional 'resilience,' designers are frequently featured in central synthesizing roles within larger multi-disciplinary teams with a range of expertise from ecological sciences and engineering to finance and governance (Weisz, Blumberg, and Keenan 2015). The aspiration towards greater integration and comprehensiveness in flood infrastructure planning is part of a larger project of developing "urban resilience" based in a understanding of cities as "complex socio-ecological systems" (Cote and Nightingale 2012; Holling 1973; Fiksel 2006). Though the concept of "urban resilience" has been criticized for its lack of conceptual clarity and for justifying 'bouncing back' to unjust status quo conditions, it has gained considerable traction among governments, philanthropies, researchers, and practitioners (Jabareen 2013; Davoudi 2012; Vale 2014b).

Many contemporary efforts to remake urban water management are linked to practices that have emerged in recent years in the Netherlands, as that low-lying nation has faced the limitations of their 20th century structural flood protections and mounting climate change threats (see Chapter 5) (Schut, Leeuwis, and van Paassen 2010). Spatial planners and designers have played a prominent role in Dutch water management as strategies have shifted from 'vertical' approaches like levees and flood walls to 'horizontal' landscape-based strategies for retaining and infiltrating water (Warner 2008). The role of design in these emerging practices has focused on maximizing flexibility and pursuing multiple benefits beyond flood mitigation, including aesthetic, recreational, economic, and ecological values (Meyer 2014; Nillesen et al. 2016). These projects are frequently framed as developing "win-win" and "no regrets" actions that will bring benefits regardless of the uncertainties of climate change (Haasnoot et al. 2013). While this framing of flood and adaptation planning has gained momentum, critics have charged that this "everybody wins" orientation can constrain discussions of the distributional consequences of adaptation efforts (J. A. Lewis and Ernstson 2017).

The design disciplines have contributed to recent regional environmental and adaptation planning through improvements in the process, content, and communication of planning proposals. In the midst of complex planning processes, the tools and methods of design can contribute in a number of ways,

[10] 20th century designers, from Le Corbusier (Fishman 1982) and Hilberseimer (Hilberseimer 1949) to Doxiadis (Doxiadēs, Papaiōannou, and Athēnaïko Kentro Oikistikēs 1974) and Frank Lloyd Wright (Levine 2016) to Frederick Law Olmsted (Eisenman 2013) and Ian McHarg (McHarg 1969) developed ambitious regional design proposals.

including: enabling synthesis across normally disparate modes of analysis; supporting decision making through joint conceptualization; and creating space for new insights (Kempenaar et al. 2016). Researchers indicate that design visualization tools can enable discussion and decision making about "alternative futures" at a range of scales (Weisz, Blumberg, and Keenan 2015; Kempenaar et al. 2016).

While design tools and methods can make significant contributions in complex planning processes, researchers have also found some significant limitations, challenges, and dangers. There may be clashes in "disciplinary cultures and traditions" between designers and other disciplines (Kempenaar et al. 2016). Researchers have recognized that design representation is a form of "rhetorical action" that can be used to persuade and to "minimize conflict" surrounding changes in the built environment of cities (B. Shannon and Banerjee 2017). The persuasive power of design visualization can be used as deceptive "design marketing" to constrain rather than enable public debate or to misinform the public and decision makers about the likely impacts of a project or program (Groulx and Lewis 2017). Because visualization is typically controlled by "already politically and economically privileged actors within the planning process," it can become a tool for reinforcing existing socio-economic and political power inequalities (Groulx and Lewis 2017).

Recent analyses of the persuasive uses of design visualization continue long-running discussions of various forms of professional abstractions and representation in planning. The ability to mobilize the persuasive tools of design is part of what Forester calls the "information management" function of planning (Forester 1988). Design visualization methods are central to the particular forms of simplification and communication in planning, what Cliff Ellis calls the discipline's "professional worldview" (Hommels 2005). Lisa Peattie recognizes competing professional "representations of reality" which, like "all forms of representation are abstractions from reality which bring some aspects forward to the attention and leave some in the background or eliminate them completely" (Peattie 1987). Similarly, Fischler observed that that planners, based on their training, "understand and represent the world in certain ways" that are "necessarily selective and partial." These abstractions significantly shape "one's definition of the problem" (Fischler 1995). This ability to strategically define a problem is an important form of political power in that problem framing can dramatically shape the type of policy or planning responses deemed appropriate (Kingdon 1984; Schon 1983).

Critical observers have long raised concerns regarding the tendency of state actors to enact spatial and social control using the analytical and representational abstractions of planning and design (Lefebvre 1991, 2003). Peattie observed that "form and content are intertwined. What can be said depends on the language for saying it." She argued that the distant and idealized forms of representation used by planners meant that "planning as a process was one which managed information selectively to the disadvantage of the small and the local" (Peattie 1987). Like Scott (Scott 1998), Holston identifies modernist design and planning as a central tool of spatial and social control (Holston 1998). Both see the geometric precision and order of modernist planning as an expression of the state's aspirations for itself as an efficient, transparent, and orderly wielder of power and for its citizens, as rational and obedient actors. Holston describes modern planning as inhospitable to "the paradoxes of its imagined future" and a project which "attempts to plan without contradiction, without conflict" (Holston 1998).

The imagined futures of modernist design and planning are frequently linked to imagined or idealized histories. State powers use design as a tool to link modernizing projects to imagined or highly-selective histories, frequently tied to place-based myths of national identity. Capitol complexes in newly independent post-colonial countries express aspirations for the future fused to unifying visions of a pre-colonial past (Vale 2014a). Architects reimagine the vernacular buildings of Egypt as part of a larger

project of national identity formation (Mitchell 2002). Dam builders in Greece use allusions to classical architecture as a means of tying infrastructural modernization to a proud ancient history (Kaika 2006). In such historical design quotations, Holston sees the production of imagined futures and invented pasts as part of the project of depoliticized planning, which "attempts to fix the future – or the past... by appealing to precedents that negate the value of the present circumstances" (Holston 1998).

While planning and design have long been used by states to mobilize power in urban space, the imperative of adapting cities to climate change has created a new set of contestations. Several scholars have remarked on the tendency in climate change rhetoric to invoke crisis as a means of constraining debate. Swyngedouw "rejects the apocalyptic imaginary" of climate change as an "inherently depoliticizing and reactionary" (Swyngedouw 2015). He regards the invocation of climate crisis as an attempt at "evacuating dissent" (Swyngedouw 2010) in order to justify "radical techno-managerial restructuring" to "sustain capitalist urbanity" rather than questioning its underlying contradictions and crises (Swyngedouw 2015). In their case studies New York and New Orleans, Gotham and Greenberg, identify a similar pattern, wherein powerful interests use "crisis driven urbanization" "to advance and legitimize radical policy reforms and redevelopment projects that would be far more difficult to implement in normal times" (Gotham and Greenberg 2014). This opportunistic use of crises to advance ideological restructuring of cities has been widely discussed in the years since Hurricane Katrina (Klein 2008; N. Smith 2006; Marcuse 2013). Hodson and Marvin identify "secure urbanism and resilient infrastructure" as one particular form of depoliticized crisis mobilization that can lead to heightened inequality both within and between cities (Hodson and Marvin 2009). To these critiques of the crisis framing of climate change, Swyngedouw adds Badiou and Zizek's critique of ecology as "the new opium for the masses," whereby the promise of ecological modernization solutions to climate change forestalls critique of the deeper roots of political and ecological destruction (Swyngedouw 2010). Hodson and Marvin also identify the potential for depoliticizing ecological discourse to exacerbate inequality through the production of "premium ecological enclaves" (Hodson and Marvin 2010b).

Given the legacy of uneven impacts created by the abstract modes of analysis and representation in planning and design, several recent scholars have questioned the contemporary embrace of consensus-based planning. Observing the tendency of contemporary planning in the Global South to reinforce radical socio-economic inequality, Watson observes that the "goal of consensus in planning processes needs to be treated with caution" and that "planning should start from the assumption of a conflict model of society" (Watson 2009). Also wary of the depoliticization of planning, Swyngedouw celebrates agonism or dissensus, concepts championed by Mouffe and Ranciere respectively, through which "oppositional positions between enemies become articulated and organized as oppositional encounters between adversaries" (Swyngedouw 2015). Miraftab has proposed "insurgent planning" as a radical counter-hegemonic means of repurposing the tools of planning to imagine and enact alternative futures with marginalized people and interests at their center (Miraftab 2009).

Dutch Water Expertise Exports

Dutch water experts have been deeply involved in recent flood infrastructure proposals in cities around the world, including in Dhaka and New Orleans (see Chapter 5). Designers and planners from private practice and academia have been a central part of the marketing of the "Dutch Water Sector" as an "export industry" (Zaken 2014; Goh 2015). Building off of Ian McHarg's concepts of layered ecological planning and landscape suitability analysis as exemplified in the Pontchartrain New Town In Town proposal in early 1970s New Orleans and the anti-levee DMAIUDP plan for Dhaka in the early 1980s, Dutch designers like Han Meyer have developed the concept of "delta urbanism" to describe design principles for manipulating the layered natural and human processes of cities to more harmoniously

adapt to the dynamics of delta landscapes (Meyer 2014).

Chapter 5 made the case that recent Dutch-influenced flood management projects may not yet herald the coming of a restorative new paradigm. In fact, many recent projects threaten to reproduce the same unwise and unjust patterns as previous flood mega-projects. This chapter considers recent projects in Dhaka and New Orleans to analyze how the tools and methods of design and spatial planning may contribute to both the positive potentials and the dangers of this new generation of urban flood mitigation projects. Given the leading role of Dutch experts in many recent projects, the following sections briefly introduce the role of Dutch designers and planners in recent water planning efforts in New Orleans and Dhaka.

Dutch Designers in New Orleans

More than anywhere else in the USA, the low flat landscape of south Louisiana and the levee and pump dependence of New Orleans are reminiscent of the deltaic landscapes and cities of the Netherlands. Even so, there was relatively little interaction between New Orleans and the Dutch water sector for most of the city's history. A 1965 report from the Netherlands Consulate General in New Orleans does not mention water management or flooding at all (Netherlands Consulate General, New Orleans 1965). By most accounts, before Hurricane Katrina, the interactions between the USA and the Netherlands on water issues were rather limited: in the early 20th century the Netherlands imported Wood Screw Pumps like those designed for New Orleans; the American military played a critical role in the response to the devastating floods in the Netherlands in 1953. Following the devastation of New Orleans and the Gulf Coast during Hurricane Katrina in 2005, Dutch designers, engineers, and scientists have been central in a series of projects to remake how the city relates to water, including the *Dutch Dialogues* (Meyer, Morris, and Waggonner 2009) and the subsequent *Greater New Orleans Urban Water Plan* (Waggonner & Ball 2013). Along with scientific and modeling expert from institutions like Deltares, many Dutch designers have played important roles, including: Han Meyer of TU Delft, Palmbout, Bosch Slabbers, HNS, and Robbert de Konning. These post-Katrina projects laid the groundwork for the City of New Orleans' Rockefeller Foundation-supported *Resilient New Orleans* strategy (City of New Orleans 2015), which advocated a revolution in how New Orleans copes with water. Unlike several politically-contentious post-Katrina proposals discussed in Chapter 5, these Dutch-influenced projects did not recommend substantially shifting the alignment or configuration of the city's levees or lands use. Rather, they called for acting strategically and opportunistically to introduce a range of 'green infrastructure' features into the fabric of the city. Interventions were intended to slow down and retain stormwater within the levees, a marked reversal from generations of drainage strategy in New Orleans, where the goal had always been to deliver rainwater as quickly and efficiently from city streets to mechanical pump stations and then to Lake Pontchartrain. Several projects recommended in these proposals have been carried out, most prominently under the ongoing *Gentilly Resilience District* project, which received funds from the National Disaster Resilience Competition to build green infrastructure interventions in one low-lying and flood prone neighborhood. Landscape architects, architects, urban designers and spatial planners from the Netherlands and the US have all been very involved in these projects.

One New Orleans planner explained the newly prominent role for designers in the city's water planning as a direct outgrowth of the Dutch involvement saying, "it is kind of a natural progression... Post-Katrina everyone was looking to the Dutch. Architects and spatial planners have been heavily involved in these projects in the Netherlands" (Birch 2017). Building off of their work in post-Katrina New Orleans, Dutch water experts and designers have been central players in post-Sandy efforts in the New York City metropolitan area ("Rebuild By Design" n.d.) and climate resilience planning and design initiatives in other American cities preparing for the impacts of climate change, including Norfolk, Virginia and the

San Francisco Bay Area.

While many of the prominent post-Katrina water planning projects in New Orleans have focused exclusively on changing strategies for drainage within the city's levees, the Changing Course competition sought to bring Dutch water management approach to the broader regional context of the lower Mississippi delta (see Chapter 5)[11]. The Changing Course competition built on the ongoing Louisiana Coastal Master Plan process by placing designers at the center of multi-disciplinary teams tasked with generating visionary proposals for "navigating the future of the Lower Mississippi River Delta" ("Changing Course" n.d.). Each of the three final teams featured Dutch water experts including designers like West 8 Landscape Architecture and Robert de Konning. Competition organizers reported that they explicitly wanted to bring the Dutch "design thinking" approach to the challenge of reworking the Lower Mississippi (Cochran 2017). One landscape architect who worked on Changing Course reported that Dutch experts and designers were also eager to be involved,

> There was huge interest in the project at the beginning. When we went in for the interviews at the convention center, I'd say 60% of the guys there were Dutch. And you can always tell: tall skinny guys, colorful pants, crazy glasses. (Agre 2017)

They went on to describe a process by which the US-based team leaders sought to bolster their chances in the competition by recruiting team members from the Netherlands saying, "with West 8 and Deltares" one team "had serious Dutch cred" (Agre 2017). A Dutch engineer reported that they were recruited by an American team leader because "they knew that they wanted to have a strong Dutch partner because they saw that each of the teams was trying to have a strong Dutch connection" (Sloff 2017).

The eagerness of the Changing Course teams to include Dutch water experts speaks to a broader trend in recent New Orleans water planning projects. Dutch water expertise is viewed as both substantively valuable and symbolically useful. A New Orleans designer who has worked on several Dutch-influenced projects recognized this dual function saying that substantively, "it is helpful to shift difficult questions to these experienced [Dutch] experts," but that some of the value of Dutch participation was more symbolic than substantive. Speaking to this symbolic or theatrical value, they said, "it seems that people have more respect or deference for them... The unusual accent helps too... it's exotic" (T. Smith 2017). Whether substantive or symbolic, the increasing role of Dutch water expertise in New Orleans has brought with it several important changes including an increasing role for design and planning.

Dutch Designers in Dhaka

From the 1950s UN Krug Mission, to the 1960s World Bank project to empolder large areas of the southern coast, to the Flood Action Plan of the early 1990s, Dutch water experts were involved in many of the pivotal chapters of the 20th century infrastructural modernization of the Bengal delta (see Chapter 3) (Netherlands Water Partnership 2015). For much of that long history, the Dutch influence has come largely from consulting hydrologists and civil engineers. With the Dutch-initiated Bangladesh Delta Plan 2100, which commenced in 2013, spatial planning was among the core activities (Consultant Team BanDuDeltAS 2014). Rotterdam-based Defacto Architecture was the primary consultant responsible for bringing spatial planning expertise to the project. Defacto led a series of "Delta Ateliers," cross-disciplinary charrette-style sessions for the project team. They were also the primary entity responsible for preparing the BDP's analysis and recommendations for the "urban areas hot spot" one of seven primary areas of work. Defacto's founder is Anna Loess Nilleson, an urban designer with extensive

[11] Like Rebuild By Design in the New York metropolitan areas, the Changing Course competition was partially sponsored by the Rockefeller Foundation and organized by the Van Alen Institute.

experience in similar "delta urbanism" planning and design processes.

The BDP's "urban areas" proposals embody "delta urbanism" principles and present significant departures from the conventional engineering practices. The urban strategy report includes emblematic designs for flood mitigation strategies integrated into the urban fabric of Bangladesh's cities, including "improved khals," canals designed to accommodate fluctuations in water level and to create amenity space. The *Urban Areas Strategy* proposes flexible floodable landscapes and infrastructures designed to accommodate future expansion. It calls for protecting the floodable space "either by assigning a placeholder function (like a public waterfront) or by only allowing flexible functions that can easily be removed when needed (such as small wooden or steel market spaces)" (Figure 6.1).

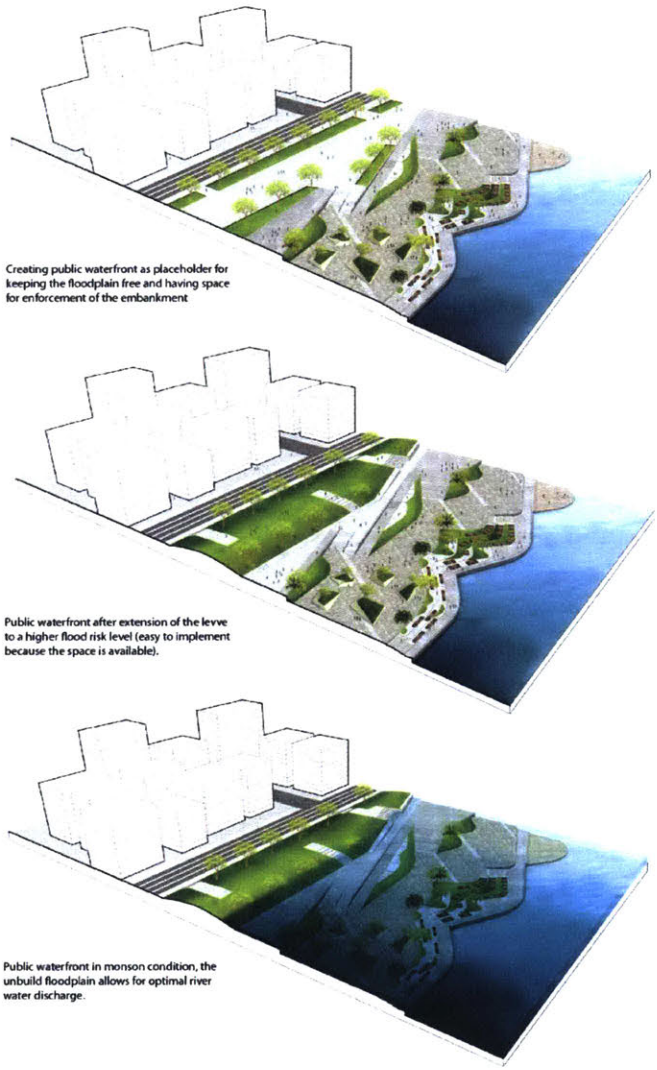

Figure 6.1. Proposed floodable park for urban waterfronts, from the BDP2100 *Urban Areas Strategy.*

In each of these examples, the urban strategies team, recommended green infrastructure as a means of providing flexible flood mitigation while creating other urban amenities. The recommendations are richly illustrated with numerous visualizations. Though the reports do include photographs of specific urban conditions in Dhaka and other Bangladesh cities, all of the visualizations showing proposed

changes to urban infrastructure are, in the words of one of the design-leads, "more exemplary" (de Kort 2016), showing generic urban conditions with white three-dimensional volumes rather than specific places in Dhaka or elsewhere.

Several participants in the BDP described the inclusion of Dutch-style spatial planning and urban design as a key component of the project, differentiating this effort from Bangladesh's numerous previous water resources planning processes. A senior Bangladesh government official said that "spatial planning was never considered before in infrastructure planning" and that the inclusion of these methods in the BDP was based on the "example from the Dutch" (T. Rahman 2017). Speaking of the centrality of design visualization to the Dutch approach, a designer from Defacto who worked on the BDP said, "we could have also decided not to do [the images], but then.... where is the Dutch?" (de Kort 2016). As in the Changing Course competition and other recent flood mitigation projects in New Orleans, the BDP represents the exporting Dutch water expertise with a prominent role for spatial planning and design.

The Contributions of Design and Planning to the New Paradigm of Flood Infrastructure

In both Dhaka and New Orleans, the use of new Dutch water management practices has been driven by the widespread opinion that previous models of dry city infrastructure – rooted in civil engineering solutions for structural flood protection and mechanical drainage – have failed. For many participants and observers in recent projects, the prominent role of designers and spatial planners was a signal that a new paradigm is under construction. This new paradigm of water management is often presented as repairing the damage done by previous levee-and-pump projects. A senior city official in New Orleans described this shift, saying,

> This idea that the city is a feat of engineering... that has ruined us. And now we have to go back to come to a new understanding of how the city fits in the environment... We have to retrofit... Designers are engaged in trying to right the wrongs of the engineering era... Back in the day, engineers just built shit because they had concrete and motors. Now we actually have to understand and respond to the natural systems. (Hebert 2017)

In this framing, design is a critical component of the restorative project, repairing the damage of infrastructural modernization by realigning urban infrastructures and settlements with natural systems. In interviews, participants in recent and ongoing water management projects in Dhaka and New Orleans largely embraced the increasing role of design and spatial planning. They identified a range of contributions that generally fit in one of three main categories: (1) improving the *process* of water planning projects; (2) enriching the *products and proposals* of these processes; and (3) making the *communication* of these proposals to the public more persuasive. The sections below discuss contributions in each of these three areas before turning to the associated challenges and dangers.

Process: 'Sloppy Thinking' for Multi-Disciplinary Synthesis

Many observers and participants reported that design and planning tools had improved the internal multi-disciplinary analysis and deliberation processes of recent flood planning projects. Several people observed that designers brought a more open and holistic view of "problem setting" to water planning processes that can otherwise be limited in scope. One of the organizers of the Changing Course competition observed that,

> Engineers very much focus on a narrow definition of the problem. Designers seem to try to fit the problem within the larger process or context and then figure out how to address it (Cochran 2017).

A senior Deltares official similarly recognized design disciplines as offering a more opportunistic and open framing of problems, saying

> Opportunities come from design. It is not enough to talk only about problems. We, at Deltares, are stars at making problems, but this is not enough. An older colleague, once told me, "If there is no solution, there is no problem." We need designers to come up with creative possible futures (Van de Ven 2017).

One Dutch designer who worked on the BDP reported that the "Delta Atelier" charrettes that they led were essential to "getting the problem framing right" (de Kort 2016), while another described the same workshops as allowing people from different perspectives to "come to a better understanding by hearing how different people view a problem" (Loes Nilleson 2017).

Related to this open problem setting process, multiple designers mentioned that they deploy a practiced looseness and naivety to facilitate the early stages of complex water planning projects. A Dutch designer who worked on the BDP described this quality as "sloppy thinking" saying,

> Designers can restructure issues to reformulate, connect, and combine. In some ways we are more sloppy thinkers, but it can help people to understand the point of view of others. (Loes Nilleson 2017)

For many designers, the act of drawing was an essential element of what they can contribute to making these processes both more open and more grounded. As one Dutch urban designer put it, "they talk, they talk, but with drawing you can have a different discussion" (Thomaesz 2017). Another Dutch designer explained the central place of visualization in facilitating discussion saying,

> of course it is very important, because you need to visualize something to talk about it with a group. Drawing is also a way of getting to know something... for us drawing together in a group, it helps to create collaboration. Showing different possibility. (de Saalm 2017)

On a similar note, a Dutch urban designer reported that they use visualization to arrive at, not only a common understanding of a problem, but also a shared image of the object of study, the city, saying, they "use drawings to change the conversation and to get people to have a common understanding of what the city is" (Thomaesz 2017).

Several participants and observers spoke of the particular value of imprecise visualization methods in enabling deliberations to moving beyond well-worn conventional solutions. A Dutch landscape architect who worked on several New Orleans projects proudly showed his "special drawing instruments," stout crayon-like colored pencils that are too thick to allow for precise drawing. The wide lines created by these pencils enforce a level of looseness and imprecision that he regarded as essential for facilitating early stage design processes. Of these early visualizations, he said "drawings should not be tidy at this stage" (de Konning 2017) (Figure 6.2).

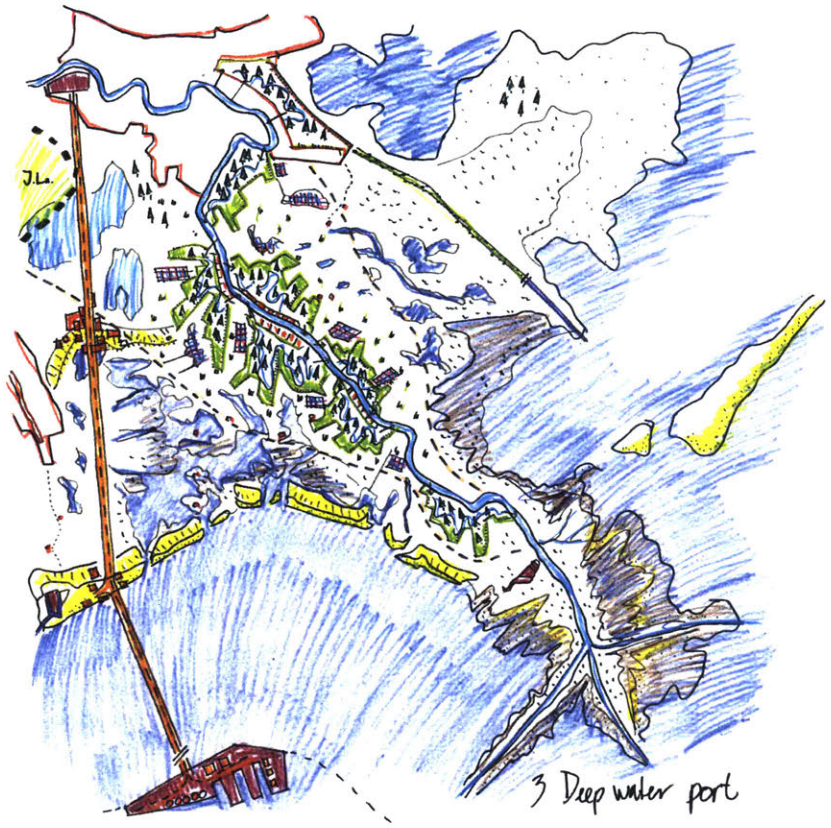

Figure 6.2. Loose and imprecise early stage sketches from the Changing Course competition. (de Konning 2017)

Another Dutch designer described the value of simple diagrammatic drawings in complex large-scale projects, saying "with these kinds of regional planning projects the drawings can show the simplified schemes… exaggerating what is important and leaving out other things" (Thomaesz 2017). A New Orleans-based architect embraced this intentionally simple visualization style saying, "some of the Dutch landscape architects draw in a very clear… almost cartoonish way… It has changed how we represent things in our office" (T. Smith 2017). An American landscape architect who worked on Changing Course described a strategy of linking performative naivety and imprecise visualization, saying

> We also came in and asked lots of dumb questions… We brought a bunch of big crazy drawings… the canal to Baton Rouge… the giant levee around the whole coast. Just to start the conversation so that we could ask: "Why not?" We played very dumb… and said… "Can you tell me why?" (Agre 2017)

While these tools for loose and imprecise visualization can play a productive catalytic role in complex planning processes, the example of the "Green Dot Map" discussed in Chapter 5 also clearly illustrated the limitations and dangers of these strategies. Recognizing the possible tension between how process visualizations are viewed by their creators and how they are interpreted by the public, one Dutch designer observed of that the "Green Dot Map" was "intended as a discussion, but it was interpreted as against the lower economic status people… the mostly ethnically African-American people… there is a very sensitive history there" (de Saalm 2017). In short, without proper understanding of context, imprecise visualizations can trigger very precise points of political contestation and distrust. Later sections will comment further on this issue of the context-sensitivity of visualization politics.

Several observers commented on the ability of designers to bridge across disciplinary divides to forge new syntheses. One landscape architect said, "the main contribution that we can bring as Dutch designers is this collaborative approach. Here in the Netherlands, landscape architects are connectors with different disciplines" (de Saalm 2017). An American landscape architect who worked on Changing Course similarly identified synthesis across disciplinary boundaries as the core value of designers in the process, saying "I think this is really what we brought... engineers don't do that" (Agre 2017). Several designers indicated that their ability to generate visualizations as part of the early collaboration process was essential to building cross-disciplinary understanding. A Dutch landscape architect reported that drawing was a critical tool for bridging not only between disciplines, but also between languages and national differences, saying

> We draw and talk together... I draw along, others talk.... there are lots of questions... We make sketches to find a common language. Drawing is also international. With words, it can be hard to communicate sometimes. (de Konning 2017)

A senior Deltares official who has worked extensively in New Orleans, similarly spoke of the power of visualization to facilitate the development of shared visions across different disciplinary and international contexts, saying "The best way is the co-creation of drawings... to arrive at a shared understanding of what a line means" (Van de Ven 2017).

Participants in recent water management projects in Dhaka and New Orleans spoke enthusiastically of the positive contributions of design tools and methods in improving these complex planning processes. In particular, they praised "sloppy" design thinking and the loose and imprecise methods of early stage visualization. These methods of open collective deliberation and representation were seen as enabling more creative problem setting and stimulating debate and discussion. Participants were especially enthusiastic about the capacity of these methods to breakdown entrenched discipline-constrained modes of deliberation to enable learning and problem solving.

'Making Everyday Better': Design Enabling Improved Proposals

Many participants in recent water planning projects reported that design methods also improved proposals. As in the process contributions, many of the contributions to proposals related to the need for cross-disciplinary synthesis and the pursuit of multiple objectives. Several people spoke of designers as ensuring that water management projects delivered benefits beyond immediate hazard mitigation. A senior Deltares official said that a good "multi-functional design" project allows people to "enjoy the benefits everyday, not just that one day in 100 years when the extreme event comes" (Van de Ven 2017). An American landscape architect identified this multi-benefit approach as "a very Dutch approach" saying,

> Since they have no space, they would never build a dike here and a park over there. No, they would just put the park on the dike. It is sort of a Dutch thrift thing... always trying to get three for one... get an economic return, a great designed place, and great infrastructure. (Agre 2017)

One of the organizers of the Changing Course competition specifically noted the role of design visualizations in this synthesis process, saying

> The visualizations added so much and they tie all the pieces together... they were all really good about pulling all the pieces together. Looking across solutions to synergies to make it a system. (Peyronnen 2017)

While many noted the role of designers in pursuing multiple benefits, some specific benefits were mentioned repeated, including: beauty; connection to cultural, landscape, and historical context; and legibility. Several people spoke of the importance of considering the aesthetic experience of water infrastructure. A senior city official in New Orleans said,

> Designers can help understand and create multiple benefits. They can make projects that are functional, but are also bringing other benefits to the community and creating civic beauty… which I think is truly very important. (Hebert 2017)

A Dutch urban designer who has worked extensively in New Orleans described this emphasis on the experiential and aesthetic dimensions of infrastructure as a particularly Dutch contribution, saying,

> I think there is something to bring from the Dutch tradition of handling these [water and flooding] issues in an opportunistic way. But you have to dare to talk about beauty and the experience of cities. (Thomaesz 2017)

Another Dutch designer who worked on the urban strategy for the Bangladesh Delta Plan emphasized the inspirational value of design visualization to show the capacity for aesthetic improvement, or as they described it, "quality." They said,

> We really just hoped to show how things could look… how you could add quality to the urban landscape… if you can gain urban quality then these [canal] areas won't be seen as sites for solid waste dumping or sewerage. (de Kort 2016)

In this framing, the capacity for designers to improve the aesthetic experience, "civic beauty," or "urban quality" of water infrastructure can actually improve their functioning.

For several observers, design tools offered an important means of reconnecting water infrastructures with their specific contexts. Many proposals for contemporary flood management projects in Dhaka and New Orleans are framed as re-engaging place-based solutions and knowledge in order to restore balance between human and natural systems. This *restorationist* narrative is frequently framed as returning to a place-based cultural heritage of more harmonious relations between people and place. The *Resilient New Orleans* strategy uses such a restorationist argument in saying,

> Rather than resist water, we must learn to embrace it, building on the confluence of Louisiana's culture, history, and natural systems. As we look to the wisdom of the past, we must also prepare for the risks of the future. (City of New Orleans 2015)

In Dhaka, opponents of conventional flood engineering mega-projects have also long appealed to a notion of a harmonious place-based built environment tradition. During the city's rapid growth over the later 20th century, there were ongoing debates between those like the military dictator Mohamed Ershad who promoted levees as a "permanent solution" to the "flood problem" (*Bangladesh Observer* 1988c) and those who regarded fluctuating water levels as part of the essential character of the landscape and argued for planning strategies to create urban settlement patterns that could accommodate water through open canal systems built "on traditional lines" (*Bangladesh Observer* 1988b) (see Chapter 3). Several contemporary critics of the levee-based 'cordon approach' to levee construction in Dhaka similarly propose a return to traditional settlement patterns of "dig, elevate, dwell" (Islam 2017). Iqbal Habib, the Dhaka architect who has worked extensively on green infrastructure and water management spoke of the Hatirjheel project as "reviving" what he called Dhaka's tradition of "water urbanisms" by "beautifully correcting" the damages wrought by past urbanization and infrastructure decisions. In the words of Nazrul Islam, a prominent critic of embankments in Bangladesh, contemporary water management must repair the damage of the past to "let the delta be a delta" (Islam 2016a).

For these restoration minded critics of modernizing infrastructures, design is critical to the project of repairing the literal and symbolic connections of urban infrastructures and settlements with their geophysical and cultural contexts. A New Orleans-based designer spoke of contemporary water infrastructure projects as reestablishing "cultural connections" by making the "assertion that what infrastructure looks like matters" and that "infrastructure needs to be more of the place" (Chang 2017b). A senior city official in New Orleans made a similar case about the need to reconnect the urban

fabric and architectural patterns of the city to underlying environmental forces. He remarked that, before the levees and pumps were built, New Orleans,

> had this building stock with high ceilings and transom windows, elevated... and we didn't build in the lowest areas. And then, right after World War II, the engineers decided that they could solve every problem... We pumped all the water out of the city. We built slab on grade, without respect to the natural hydrology. This idea that the city is a feat of engineering... that has ruined us. And now we have to go back to come to a new understanding of how the city fits in the environment... We have to retrofit. (Hebert 2017)

In addition to aesthetic considerations and restoring the symbolic and physical connections to context, several participants in recent water projects spoke of the role of designers in rendering water infrastructure more legible. Where dry city infrastructures of levees, floodwalls, pumps, and pipes, made water and the infrastructure for managing it invisible, many contemporary projects have a demonstrative, pedagogical, or legibility function. Some designers spoke of using the tools of design to remind residents of New Orleans that their city is in the midst of a vast wetland, repairing what one called "a disconnect between the city and the water" (Chang 2017b). One Dutch designer spoke of this symbolic or visual reconnection, describing the redesign of New Orleans' canals as "an opportunity to give a new identity to the urban environment" where "the wetland environment [can] be brought into the city. You won't have actual swamp in the city, but you can get inspiration from the swamps" (de Saalm 2017). A New Orleans-based landscape architect described their emphasis on legible landscapes saying that green infrastructure "need[s] to be understandable and approachable and accessible. What you see is what you get. We are not hiding function like they use to do with pipes" (D. Brown 2017).

Referring to a somewhat different dimension of legibility, a city official in New Orleans who has worked extensively on the city's water projects spoke of the role of designers in giving many of the city's efforts a "common branding language." Specifically, they described the inclusion of an orange bench on several "stormwater lots," vacant lots that had been repurposed to retain stormwater by the city's redevelopment authority. The orange benches were intended as an "educational" strategy to signal to users and residents that though projects "will all look very different" each "is part of a bigger system" (McHugh 2017).

Participants and observers in recent ambitious water planning projects spoke of design and spatial planning as improving the substantive products of these processes by supporting their capacity to deliver multiple benefits simultaneously. They discussed a range of benefits beyond the immediate hazard mitigation functions, including: improved aesthetic and experiential value, connections to cultural and landscape context, and greater landscape and infrastructure legibility.

Communication: Design as Inspiration, Explanation, and Persuasion

Along with the improvements to planning processes and products, several participants spoke of the contribution of designers and planners in enabling the communication of recent water planning efforts. Designers are among the most active public spokespersons for alternative flood mitigation strategies in Dhaka and New Orleans. Iqbal Habib, a Dhaka architect and environmental activist estimated that he has done "more than 80 seminars" (Habib 2017) and another local architect said that Habib is "totally public... on TV talk shows every night" (Ashraf 2017b), speaking on a range of environmental issues including green infrastructure projects. Architect David Waggonner has fulfilled a similar role in New Orleans as a frequent public advocate for green infrastructure. In addition to acting as public spokespersons, designers have also taken a central role in communicating new flood mitigation strategies to the wider public through visualization. There was broad agreement among interviewees on

the power of visual representations in making the case for shifting water infrastructure approaches. However, people recognized different mechanisms of influence, including: providing a galvanizing vision; making a narrative case; educating the public; and describing the trade-offs and complexities of dynamic projects. The sections below discuss these themes briefly.

Vision

Many people mentioned the importance of design visualizations in providing a tangible vision for alternative futures in flood mitigation. In Dhaka, designers described the power of visual representations in a context where the politics of planning are widely viewed as hopelessly corrupt and the capacity for spatial governance is limited. One local architect and civic leader spoke to this power of design saying,

> You have to provide images of the future. Design is all about a possible future. I believe in utopia, the power of utopia... In Bangladesh the image is more important and this is a new thing here... Whether it will be built or not, we cannot talk about that today... But it can build desire and that desire can become a demand and maybe that can create change. (Ashraf 2017a)

Another Dhaka architect and activist also spoke to the political power of design, saying

> it is my job to make people shocked everyday... to show the people what is happening [with corrupt and damaging urbanization processes]... As I am an architect, I show some sketches of how things could be different. My job is to make people angry. (Habib 2017)

They described "reestablishing water urbanism in Dhaka" as part of "regaining the belief of the people... even if the land is taken over by the powerful people." Speaking of the inspirational power of these projects, he said, "This is not just another project; this is an audacity!" (Habib 2017).

In New Orleans too, several people spoke in similar terms about the catalytic power of visualizations to advance alternative futures. The organizers of the Changing Course competition explicitly focused on generating visualizations for "out of the box" proposals. An engineer involved in the competition said "It really helps to be able to present a positive vision for what the area could look like" (Wilson 2017). Dutch designers involved in New Orleans water planning also referenced this role. One said "we can put the vision out there, we can get people enthusiastic" (de Saalm 2017) while another specifically referenced the importance of diagrammatic, non-photorealistic visualizations in creating a politically potent vision for urban transformation. As an example, they described a simple sketch of Rotterdam's water urbanism proposal, saying,

> This drawing is in the mayor's office because it is the icon of the city. It is not just about atmosphere, which is what many collages are. It is about offering a new comprehensive image of the city... They are not exact, but they are about the vision of where do we want to go. (Thomaesz 2017)

Narrative

Several participants in these projects spoke of the tools of design as essential to constructing public narratives in support of changing infrastructure strategies. A Dutch engineer described the storytelling value of visual representations saying, "visualization is very important because it can tell a story much more than a lot of words" (Van de Ven 2017). A New Orleans-based designer specifically connected the narrative power of design to the need to explain the historical processes of urbanization, saying that designers are capable of "communicating in a more spatial and visual way... to show people where problems are and to tell the story of a place... to explain the narrative of the place" (T. Smith 2017). A Dutch designer with extensive experience in New Orleans made a similar point on the need to explain the historical roots of the city's water challenges through visualization, saying, "I can draw two sections [of New Orleans], one from 1600 and one from today, and people will understand why New Orleans is in trouble" (Thomaesz 2017). An American landscape architect who worked on the Changing Course

competition emphasized the rhetorical power of design in their process, saying, "we tried to come up with a clear narrative… to keep the strategies as clear as possible and to keep the hierarchy clear" (Agre 2017).

Participants in these projects recognized that, as Donald Schön showed, metaphors can be "generative" by providing new "perspectives or frames" on a challenge (Schön 1993). The Dutch consultants on the Bangladesh Delta Plan used the paired metaphors of the banyan tree and the shapla or water lily to explain two approaches to water planning in the delta (see Chapter 5). Where the banyan tree represented "engineered control," the shapla, which is also the national flower of Bangladesh, represented a more landscape-sensitive "adaptation by design" approach (General Economics Division 2016). Metaphors were also central to the narrative communication strategies used in the Changing Course proposals for south Louisiana. The team which included Dutch landscape architecture firm West 8 and the LSU Coastal Sustainability Studio drew on the metaphors of the National Forest Service and the transcontinental railroad as precedents for the "governance for large scale, long-term landscape management" and the "scale and ambition for iconic civic infrastructure" needed in remaking the lower Mississippi Delta (Moffatt & Nichol et al. 2015). A designer from that team spoke of the value of these metaphors as making the case for a "generational" project, saying

> the analogy we used was the National Forest Service… it was really an economic development project… [It was] a few big moves…. But then most of the work was really done as just a guy planning a tree… annually, incrementally. (Agre 2017)

Another Changing Course team used the simple and memorable metaphor of faucet taps to illustrate their idea of installing new control structures to divert Mississippi River water and sediments through the levees to nourish the delta (Figure 5.11). Several observers spoke of the influence of that image, including a senior USACE official who said,

> You have to be impressed with the ideas and the vision they came up with. Like that faucet thing. Maybe that is the way to think of it. It's so simple, so easy to remember. (Inman 2017)

Among participants and observers of several recent water planning processes in Dhaka and New Orleans, the narrative function of design visualization was a central contribution of design in making the case for new infrastructural strategies. Through metaphor and other tools of visual narrative construction, designers can grapple with landscape change on scales that are not readily perceivable, strategically frame problems, and speak to issues of cultural identity and place-rooted history.

Education

Other people described the use of design visualization as a critical pedagogical tool. One New Orleans landscape architect said of their use of video and other visualization tools to explain green infrastructure strategies, "we are always thinking about the education side" (D. Brown 2017). Speaking of the reason for making design visualization a central part of the Changing Course competition, one organizer said,

> The education component was really central. We knew that we were not going to implement things that we don't have support for, so we needed to bring people along… With this kind of big change, you have to give people a way to come along. (Cochran 2017)

Some of the specific areas where participants mentioned the pedagogical value of visualizations were in communicating the trade-offs between multiple types of landscape value, explaining the day-to-day and season-to-season dynamism of landscapes, and promoting multiple "co-benefits" of proposed projects. On educating the public regarding trade-offs, a Deltares engineer who worked on Changing Course spoke specifically to the value of visualization in communicating that, while shifting from 'vertical' to 'horizontal' flood mitigation strategies might be perceived as a loss of security, these projects offer

countervailing benefits. Speaking of the public communications value of visualizations, they said,

> If we propose a linear park along a river, sometimes the water will be too high and people will not be allowed to use the park. But this is a concept that can be difficult to sell… people will say "It is my right to go to the river anytime I like. When there used to be a concrete wall, I could go anytime, but now you are taking this away." So we can use visualization to communicate tradeoffs. What other things are you offering - recreation or visual effects - to compensate for the loss of the "right" they had before? (Minns 2017)

They went on to describe how visualizations can improve the communication and design of green infrastructure projects by communicating the dynamism of the landscape over time, saying,

> You can do drawings that show what areas will be covered in water at certain times of year…. and then you can determine that maybe we need to have another path here for those times with high water. This is the kind of stuff that we [engineers] don't look at ourselves too much. (Minns 2017)

Many of the images produced by the Changing Course teams clearly communicate proposed projects' multiple benefits to different constituencies. One particularly striking example is a collage produced by the West 8 team showing a massive new infrastructure corridor in the background with heavy freight traffic and wind energy production. In the foreground, an oysterman digs, a scientist restores the marsh, and duck hunters wade with their dogs (Figure 6.3). By placing seemingly incompatible uses together in the same image, this collage and similar visualizations make the visual argument that major water infrastructure interventions will create benefits and value across a range of stakeholders.

Figure 6.3. Multiple benefits and win-win solutions as visually rendered in a Changing Course finalists' presentation. (Moffatt & Nichol et al. 2015)

Many participants spoke of design visualizations as powerful tools for persuasion. They described the utility of these tools in "selling" proposals or in getting "buy-in" from the public. One of the Changing Course organizers said of design visualization, "I think there was a huge benefit in communicating to the

public and in having them accept it" (Peyronnen 2017). A designer who worked on Changing Course spoke of design as offering alternatives to conventional scientific and engineering communication tools, which they regarded as ineffective, saying that policy makers and engineers "think that they just need more data to convince people, but you don't need more data. You need to communicate in different ways" (Carney 2017). Given the potential for the shift from vertical to horizontal flood mitigation to disrupt lives and livelihoods, many participants in these projects spoke of the rhetorical value of design visualization in persuading the public of both the need for the shifts and the benefits they would bring.

The Problems and Challenges of Design in Contemporary Flood Mitigation Planning

While many people involved with the recent flood mitigation efforts in Dhaka and New Orleans spoke glowingly about the potential for the tools of design to improve the process, products, and communication of these projects, some, both within and outside of these projects, raised concerns. As with the advantages, the dangers of increasing design participation can be broken into issues related to the planning processes and those related to the suitability and communication of the proposals. The following sections analyze these two realms through examples drawn from recent projects in New Orleans and Dhaka.

Process Challenges

Though some proponents of increasingly design-centered flood planning, celebrated 'design thinking' and visualization as improving these processes by enabling creative problem setting and collaboration across disciplines, other observers and participants have raised alarms. Two common sets of process concerns related to the tendency for designers to underestimate the value of other disciplinary knowledge and the struggles of outside designers to make sense of and adapt their methods to different professional and cultural contexts.

Naivety and Overreach

Among the process-related critiques that emerged from interviews with participants and observers of recent projects was the view that designers do not adequately recognize the limitations of their own expertise. Affirming a long held criticism of some design professions, one New Orleans-based planner said "too often design can get caught up with ego and personality," limiting the capacity to listen and collaborate effectively (Hill 2017). A Dutch engineer expressed a similar frustration, saying "in some cases there are problems [with design-led planning processes] because designers need to have more expertise or you can end up with a negotiated nonsense solution" (Van de Ven 2017). A New Orleans based scientist with experience on water planning project complained that government entities "keep hiring landscape architects to do what urban ecologists should do." They went on to say that, though "maybe [designers] are better at synthesis and presentation," they too often "monopolize ecological knowledge" and "claim ultimate knowledge over everything." On balance, this critic regarded the relative weight given to design over science in recent water planning projects like the Changing Course competition, as making these projects "marginal activities that take up too much time and money," without delivering the benefits that they claim.

These critics saw this overreaching tendency among designers as leading to projects that can be excessively image driven, ecologically ill-informed, and functionally inadequate. One Dutch engineer pointed green roofs as an example of problematic design-driven measures, saying,

> One big risk with design and designers is that they use things that are not proven... and that may not be effective or efficient. One great example of this is green roofs... Green roofs are bullshit. We are promoting something that is questionable ... because of some landscape architecture and ecological value, but these were never the benefits that were used to justify them. They

> look nice, but they are ineffective... Designers have a responsibility to correct these problems. Designers need to attract expertise from other fields.

A Dutch designer similarly raised alarms at the disconnect between image and function in New Orleans water design efforts, saying "there is lots of movement on the local scale, local rain gardens. That's cute, but that is not going to solve the problem" (Thomaesz 2017). A US-based scientist complained that because they did not have adequate ecological knowledge, landscape architects in New Orleans had built stormwater retention projects in the city taking great care to preserve highly invasive Chinese Tallow trees that should have been removed.

Culture Clash and Design Processes

Several participants in recent water planning projects in Dhaka and New Orleans indicated that some of the limitations of design tools relate to the ability of designers to understand and engage with context-specific factors in places that they are not familiar with.[12] Critics of recent planning efforts in both Dhaka and New Orleans have raised concerns about the appropriateness of deploying Dutch strategies in these very different settings. Nazrul Islam, a longtime critic of structural flood protections in Bangladesh wrote, "why does Bangladesh need a delta plan formulation process that is heavily dependent on foreign advice and financing?" and, further, "is the Dutch experience most relevant for formulation of the delta plan for Bangladesh?" (Islam 2016b). In New Orleans, observers similarly raised concerns about the appropriateness of Dutch proposals and processes. The concerns were related to a range of issues, including: climatic and hydrological differences, political fragmentation, the sanctity of property rights, and the history of contentious racialized planning processes in the region and the US at-large.

Comments from many project participants suggest that Dutch water experts are sensitive to the critique that they are peddling inappropriate solutions. A Dutch designer who has been involved in projects in New Orleans said, "Of course, you can't just parachute a Dutch process to another country, but you work to understand the local context and look for ways to bring this approach" (de Saalm 2017). Another Dutch designer with extensive experience in New Orleans spoke specifically of the difficulty of performing the integrative work of design from a distance, saying,

> It is hard when you're not there... Urbanism is about integration and that is hard to do from far away... You hope you make drawings that can do the work without you being there, but that requires a lot from a drawing. (Thomaesz 2017)

A BDP project leader similarly acknowledged the need for context-specificity in adapting Dutch strategies to the context of Bangladesh, saying,

> a successful approach requires a government strategy that is linked to the local people's tactics, and intertwined with local culture, history and interests...we have to make sure that we don't push Bangladesh into the Delta Plan in a Dutch way. It must be designed for and owned by Bangladesh" (Janssen 2017)

Such rhetoric suggests that the Dutch water experts working in Dhaka and New Orleans may have more appreciation for the need for local legitimacy and context-specific solutions than did the infrastructure modernization planners of the past. However, interviews indicate that, not only are issues of context specificity still serious concerns, but that the tools and methods of design may be particularly vulnerable to certain forms of context-insensitivity. Furthermore, because designers are frequently treated as critical translators between the universal epistemologies of science and engineering and place-specific

[12] These critiques are, of course, not restricted to designers. The illegibility of complex social and environmental contexts and the incuriosity of outside experts has long been a theme of critical development studies (Mitchell 2002; Ferguson 1994).

dynamics, the inability of designers to adequately assess and account for local context in these major water projects is especially problematic.

While several people pointed out that designers are able to facilitate loose and cross-disciplinary planning through process visualizations, this function appears be highly contingent upon how the design disciplines and their methods are perceived by other relevant project participants. A Dutch designer who worked on the Bangladesh Delta Plan spoke of the limited regard that Bangladeshi team members had for design saying, "when I explained what we do in our work, some of the Bangladeshis would say, 'Oh yes, beautification'" (Loes Nilleson 2017). A Louisiana-based designer spoke of a similar frustration with the lack of respect for designers among the major state government agency responsible for the state's Coastal Master Plan, saying "We did this massive two year project for CPRA...They treated us as if were just there to make pictures." On a similar note, a Dutch designer who worked on the Bangladesh Delta Plan spoke of a cultural disconnect regarding their visualization techniques saying, "in the beginning, we were doing lots of hand sketches... and they were perceived [by Bangladeshi team members] as kind of childish and they didn't want them in the reports" (Loes Nilleson 2017).

With this disconnect regarding the value of design visualization, the scope of work allotted for the designers for the BDP was substantially cut. One Dutch designer reported,

> We were supposed to do visualizations for the other sections, but this was cut from the budget... For us, maps are not just there to show what is in the text. They are tools for research and strategy development and they are of course also major communications tools. (Loes Nilleson 2017)

They went on to describe how the elimination of their visualizations made them re-evaluate how the tools of design were valued, saying,

> It was a major disappointment because it felt like this was a reflection of the perceived value of our skills and methods. We asked ourselves, "How did this happen?" We spent loads of extra hours on these visualizations because we really believed that they would convince people of the value... but in the end I just wondered, are we as designers just misperceiving the value? (Loes Nilleson 2017)

Thus, the disconnect between the ambitions of designers and the perceptions of other members of the project teams can substantially limit the ability of design tools to contribute to these processes.

Even as Dutch designers recognized that their preferred methods of analysis and intervention required sensitivity to the particular contexts of Dhaka and New Orleans, some of these recent planning processes have suffered from structural challenges that made building context-specific knowledge difficult. Participants in the BDP reported that their capacity to conduct outreach to better understand the planning context was limited by the project's structure and timeframe. Despite the optimistic pronouncement from a Dutch project participant that "in a short time all stakeholders have been consulted," other accounts indicate that there were severe limitations set on the team's outreach (Janssen 2017). One Dutch designer reported that their efforts to gather "local knowledge and expertise" were limited to "a series of tours" of the "hotspots" and the charrette-style Delta Atelier sessions, which only included other consultants and representatives of government agencies. A Bangladesh-based planner reported that the project suffered from an artificially compressed politically-motivated timeframe, saying,

> One major problem was that there was lots of pressure from the government to deliver the product at a specific time. We had lots of big plans... but they were all thrown out when the government told us they need the documents. Delta Ateliers were cancelled by the Planning Commission. We had to jump directly from the baseline studies to the final report... without

> doing the proper analysis. We could not implement the planning process that we wanted to. The government was keen to implement projects... so we had to make this huge leap.

According to this planner, the time pressures were particularly problematic given that many of the Dutch consultants did not have substantial experience in Bangladesh. They reported that,

> There were too many organizations with no knowledge of Bangladesh at all. This place is very dynamic... If you don't have the knowledge and you try to implement, you will have many problems... [The Dutch consultants] were asking me, why this law was not implemented or why that plan did not work. At every step I tried to explain again and again how Bangladesh works to them, but if you have people who have worked here for many years, they will just understand.

As in the BDP process, many of the people involved in the Changing Course competition were outside professionals without substantial experience in the region. In Changing Course there were also structural barriers to addressing these deficits of context-specific local knowledge. According to multiple participants in the competition, the project teams were actually forbidden from conducting community outreach or engagement. A Dutch designer who worked on the competition reported that the competition organizers limited community outreach to guard against 'planning fatigue,' saying,

> We were not allowed to talk with the community, to have contacts, without letting the organizations know. So, we were a bit on our own. We went out a couple of times to visit different places to get a look... to understand the scale. There are certain things that you just cannot do from behind a desk. The competition organizers organized community sessions by themselves because they didn't want each of the three teams going to the same group and asking the same questions... They did this to make sure that the community was not overloaded.

A Dutch engineer who worked on the competition reported that the teams were prohibited from doing stakeholder outreach because the competition organizers wanted to avoid political controversy, given the region's contentious history with past water infrastructure projects (see Chapter 5). They said,

> There was not so much public input. There were some stakeholders who were opposed and so [the competition organizers] told us, we should not have contact with stakeholders... Of course, after Katrina, lots of people were disappointed in the role of the government... There is no more trust. And so, to make the project a success they thought we should keep it a secret for some time.

Even as Changing Course and the BDP aspired to developing integral visions for changing the paradigm of water management, the processes were not designed to assimilate and use crucial forms of local knowledge, especially on topics that might invite political contestation and debate.

Interviews with project participants and observers suggest that ignoring and avoiding political contestation were pervasive themes in these projects. A New Orleans-based researcher attributed the political sensitivities and image-consciousness of the Changing Course competition to one of the sponsors, the Rockefeller Foundation, saying, "they want things that look unequivocally successful and the only way to do that is to not get into details too much." Given these limitations, they went on to criticize the competition, calling it "a joke" and "a weak ass charrette" that was not focused on making substantive progress towards saving the Louisiana coast, but was "just about collecting another notch in [the organizers' and designers'] belts."

Even as many of designers recognized the radical political differences between the Netherlands and Dhaka and New Orleans, they avoided direct engagement with contentious political issues. Speaking of the limitations on the infrastructural transformations in New Orleans, one Dutch designer said, "This is typical... In America things are so divided. Here in Holland, we are wider in thinking, so you can achieve more things. The politics change what you can accomplish" (de Konning 2017). A Dutch designer who

worked on the BDP expressed a similar consternation in discussing the political impediments to the implementation of the Delta Plan saying, "the political part... we are not used to that in the Dutch case. In the Netherlands, normally we give our advice as consultants and that's it" (Loes Nilleson 2017). Other Dutch experts who have worked extensively in New Orleans reported that they are reticent to engage with policy and politics. A Deltares engineer reported that, "we don't' get involved in policy in the US. It is just so local" (Minns 2017). Speaking of their hesitance to engage with issues of land use in New Orleans, a Dutch designer said,

> We were too far away here to be involved in that type of process. As a Dutch firm, for us to be involved in these society issues... didn't feel safe or appropriate for us to work on this. (Thomaesz 2017)

Though these projects aspired to place-sensitivity and holism, outside designers and other experts were hesitant to engage with issues that might inspire political contestation and debate.

Many recent planning projects in Dhaka and New Orleans aspire to synthesize multi-disciplinary knowledge to craft strategies for addressing contemporary flooding challenges. Experience with recent projects in Dhaka and New Orleans indicates that there are systemic blind spots in these design-led planning processes. In the view of some participants and observers, designers' impulse towards synthesis can lead to superficiality and a lack of regard for disciplinary knowledge. Though design visualizations can be a useful tool for process communication, their utility is dependent on design methods being viewed as useful and legitimate by other disciplines. Even as designers and other project participants recognize the critical importance of context-specific local knowledge, the structure of these projects can systematically devalue and exclude such knowledge. In particular, reticence on the part of designers and other experts to engage with critical political debates may limit the ability of these planning processes to be truly integrative. The next section delves deeper into the question of how the proposals generated by these recent efforts in Dhaka and New Orleans may use the tools of design to ignore, obscure, and rush past political contestation.

Design and Political Contestation in Flood Planning

Generations of flood infrastructure projects have shown that these infrastructures are "thick with politics," (Bijker 2007b) supporting some forms of settlement and livelihood and harming others. However, many recent adaptation proposals have used the tools of design to ignore, rush past, or actively obscure their political implications. As Chapter 5 argues, many of these contemporary planning projects repeat the pattern of depoliticization practiced during the earlier 20th century era of dry city infrastructural modernization. Those earlier modernization projects were typically justified on the basis that they would bring order, growth, and prosperity (see Chapters 2 and 3), while deemphasizing the uneven distributions of benefits and risks that they would generate (see Chapter 4). Project proponents used the presumed neutrality of techno-scientific and techno-managerial rhetoric to emphasize their benefits and de-emphasize their distributional consequences. Recent research on climate change adaptation has shown similar patterns. Even as adaptation has the potential for a range of serious distributional impacts (Sovacool, Linnér, and Goodsite 2015), the search for "win-win" and "no-regrets" solutions obscures serious equity implications (Anguelovski et al. 2016b).

While contemporary eco-infrastructural modernization projects in Dhaka and New Orleans often use design and spatial planning tools in their efforts to synthesize across realms of disciplinary knowledge, these projects also frequently de-emphasize points of political contestation and distributional consequences. The mechanisms through which design visualization and other tools contribute to this depoliticization include: reinforcing the landscape essentialisms and restorationism which foregrounds geophysical characteristics and minimize social and political complexity; promoting the "big

engineering" techno-managerial approaches which increase rather than decrease control over landscape dynamics; embracing "win-win" framings that suggest that obscure distributional consequences to major adaptation interventions; and invoking a sense of crisis and urgency which can 'evacuate dissent'. The sections below consider how visualization and other tools of design may specifically contribute to the depoliticization of flood infrastructure projects in Dhaka and New Orleans.

Invoking Crisis and Urgency to Rush Past Conflict

Designers, along with most other professionals working on urban flooding and climate adaptation, treat these problems as urgent. Designers in Dhaka and New Orleans referred to the project of flood mitigation as "so urgent" (Thomaesz 2017), "an existential threat" (Chang 2017b), and a matter of "urban survival" (Habib 2017). The *Resilient New Orleans* plan warns starkly, "we cannot afford to fail" (City of New Orleans 2015). Visual representations have long been used to strategically invoke a sense of crisis in the cause of mobilizing for flood infrastructural investment. Speaking to the political power of flood images, one Dhaka-based levee critic reported that in the 1980s,

> Every year during the first rain of the monsoon season, [the military ruler H.M.] Ershad would go somewhere and stand in a river and show that there was a flood. And the development people loved this. And the engineers and the bureaucrats loved this. (N. K. Rahman 2017)

Proposals from the 20th century era of infrastructural modernization to today routinely use images of devastating flooding to make the case for urgent action (Figure 6.4). The Changing Course finalists followed in this path, using visualizations to invoke a sense of crisis-driven urgency. One team included as their second presentation slide a full-screen image of a coastal Louisiana camp with Gulf waters lapping at the doorstep with the bold pronouncement, "this is urgent" (Figure 6.5).

Figure 6.4. Crisis invocation through flood scenes in the 1964 IECO Master Plan (EPWAPDA and IECO 1964) (above) and the 2016 AVIC eastern Dhaka embankment proposal (AVIC International 2016) (below).

Figure 6.5. Explicitly invoking urgency in the Changing Course competition. (Moffatt & Nichol et al. 2015)

Addressing the causes of climate change does indeed demand urgent action. Dhaka and New Orleans do face real and imminent threats from flooding. However, the severity and urgency of these problems can also be used as a justification for "evacuating dissent" (Swyngedouw 2010) and advancing aggressive reforms that short-cut established forms of democratic deliberation and legitimization. These patterns have been labeled by others as "crisis urbanism" (Gotham and Greenberg 2014) and "disaster capitalism" (Klein 2008). The sections below describe some strategies that, when paired with the invocation of crisis-driven urgency, can quash deliberation and dissent.

Techno-Managerial Revival

Given the invocation of crisis and calls for urgent action, contemporary flood mitigation efforts in both the Bengal and Mississippi deltas frequently advocate aggressive new techno-managerial infrastructural interventions (see Chapter 5). Even as proposals use more conciliatory rhetoric that suggests a relinquishing of control over landscape functions (e.g., "design with nature" and "living with water"), they are often driven by a familiar interventionist ethos, which views delta landscapes as quantifiable, measureable, and manipulable. The tools of design and spatial planning are often central to making the case for these interventions.

The continued push for greater landscape control is clearly visible in several of the Changing Course finalists' presentations. One includes several slides showing maps of the lower Mississippi delta, with the words "Our Canvas" (Figure 6.6). The analogy of the delta as an engineering and design canvas speaks to the continued dominance of heavy-handed interventionist approaches to managing the delta.

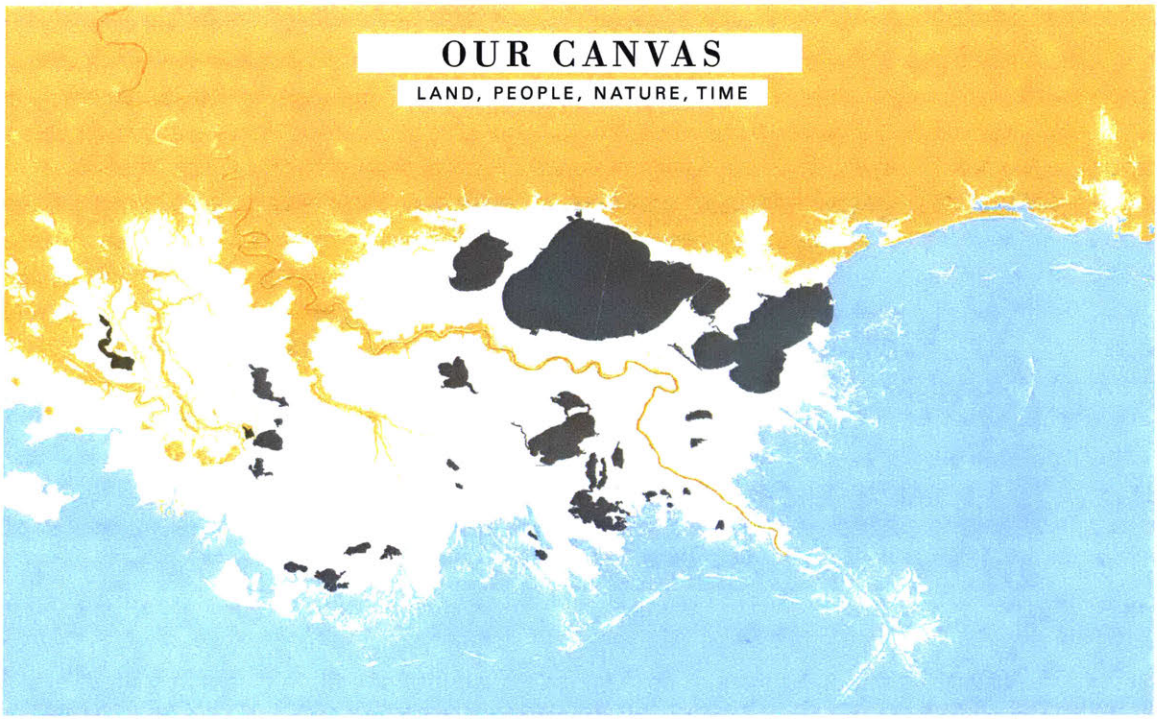

Figure 6.6. The delta as canvas and the persistence of techno-managerial control. (Baird Team 2015)

This team, led by the engineering firm of Baird and Associates, also used the visual metaphor of a faucet tap to illustrate proposed new sediment diversion structures that could be opened and closed "to distribute sediment across the delta" (Figure 5.11). Multiple project participants and observers referred to these images as particularly impactful. While this visualization and its underlying metaphor represent a new strategy, they hardly suggest a major paradigm shift away from engineered control. Rather, the proposal embraces and extends the existing paradigm of the delta as a highly engineered and controlled landscape. It was these strategies that led one Netherlands-based member of this team to apologetically refer to the proposal as a "big engineering approach."

On a similar note, an image from the Changing Course team led by the engineering firm of Moffat & Nichols expresses the epistemological continuity between the mid-20th century infrastructural modernization and contemporary efforts (Figure 6.7). The left side of the image shows a hydraulic diagram from the USACE's "1958 Project Design Flood," indicating in bold black lines and numbers the flow volume on the Mississippi River and its major tributaries and distributaries. On the right side, the image shows the team's "Giving Delta Framework" proposal in the same graphic style. This style of graphic representation of river flows commonly appeared in analyses and proposals from the mid-20th century, including those in both the Bengal and Mississippi Delta. Again, while this diagram shows a new strategy, in both the character of the strategy and the graphical style, the image signals a continued adherence to a highly abstract, bounded, and quantified conceptualization of the river and its delta that was common in the golden era of infrastructural modernization.

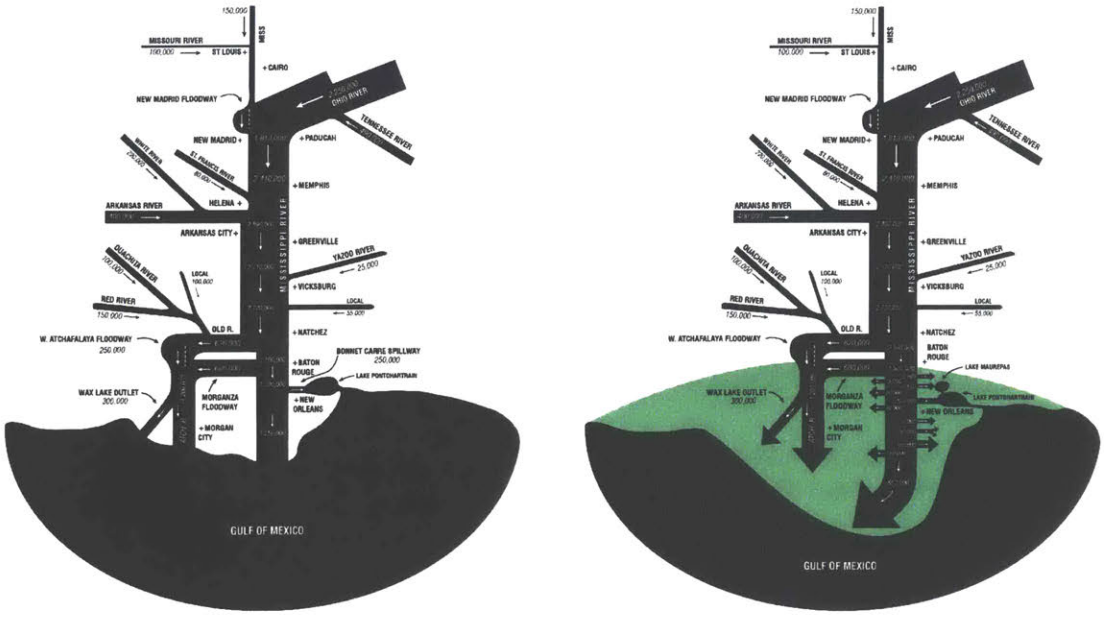

Figure 6.7. Infrastructural modernization to eco-infrastructural modernization. Representing the delta as abstract, quantifiable, and manipulable. (Moffatt & Nichol et al. 2015)

The Landscape Essentialism of Delta Urbanism

In much the same way that 20th century infrastructural modernization projects were justified on the basis of the purported neutrality of technical analysis and efficiency maximization, many contemporary projects rely on rhetoric of geophysical neutrality. Recent plans and projects in both Dhaka and New Orleans invoke the deltaic nature of the landscapes to foreground the geophysical characteristics of their settings. Recent planning efforts, design strategies, knowledge networks, conferences, and special issues of journals all focus on the delta-ness of New Orleans, Dhaka, and a set of other "delta cities." The Bangladesh Delta Plan 2100 was based on the Netherlands' own Delta Programme. It calls for "adaptive delta management," including "delta urbanism." It proposes a "Delta Act," "Delta Fund," and "Delta Commission." This foregrounding of the geophysical similarities between deltas enables potentially inappropriate and damaging transfers of practices between places, which are nominally similar in their geophysical circumstances, but otherwise radically different. This emphasis on the deltaic landscape constitutes a form of *landscape essentialism.*

This delta landscape essentialism has become a central tenet of progressive planning and urban design in Dhaka and New Orleans, arguing that the infrastructure and settlement patterns of the cities must be substantially restructured to more harmoniously align with their underlying delta landscape characteristics and dynamics. Proposals to remake urban water management in both Dhaka and New Orleans frequently invoke a need to rebalance the relationship of the city with the hydrology of the delta landscapes. As the *Resilient New Orleans* strategy report puts it, "We must align our infrastructure and urban environment with the realities of our delta soils and geography" (City of New Orleans 2015). This approach draws on the McHargian idea of landscape suitability, foregrounding geophysical characteristics and dynamics as the primary determinants of urban form (McHarg 1969).

As discussed above, the realignment of urban settlement patterns with underlying delta landscape is also frequently coupled with the aspiration to restore pre-infrastructural modernization settlement patterns. This *restorationism* is clearly evident in contemporary projects in both Dhaka and New Orleans. It is present in calls to "restore" Dhaka's water urbanism (Habib 2017) and it is present in the *Resilient New Orleans* strategy's calls to "look to the wisdom of the past" in pursuit of "learn[ing] to embrace [water], building on the confluence of Louisiana's culture, history, and natural systems" (City of New Orleans 2015). A Netherlands-based engineer who worked on the Changing Course competition spoke of the effort as advancing "conversation of how to start changing the delta back to what it once was" (Minns 2017). Much as Holston argued that 20th century modernist urbanization "attempt[ed] to fix the future … by appealing to precedents that negate the value of present circumstances," this landscape essentialism and restorationism attempts to repair the damage of modernization by appealing to imagined precedents that do not acknowledge the circumstances of the political present.

Designers contribute to both landscape essentialism and restorationism in their visualizations. Reports, books, and presentation slides display familiar satellite imagery of deltas where green land meets blue sea in swirls of tan sediment. Renderings of post-restoration delta cities show settlements blending seamlessly with the surrounding delta landscape (Figure 6.8). Plans and cross sections of proposed sediment diversion structures included in one of the Changing Course finalists' proposals exclude any evidence of human habitation in the landscape (Figure 6.9). By highlighting the underlying geophysical characteristics of delta landscapes, the categories of 'delta urbanism' and 'delta cities' help to make the case that Dutch expertise, including design and planning expertise, is relevant and transferrable to settings like New Orleans and Dhaka, where the dynamics of soil and water share some basic similarities with the Netherlands, but the urbanization dynamics and spatial governance are very different. A report from the Delta Alliance making the "Dutch business case for adaptation with a focus on the case of Bangladesh" promoted Dutch involvement in Bangladesh's water infrastructure development as a chance to "show case the Dutch approach for adaptation" as "a generic approach towards risk assessment and risk management as a universally applicable methodology for climate proofing" (Bergh, Bucx, and Guchte 2012).

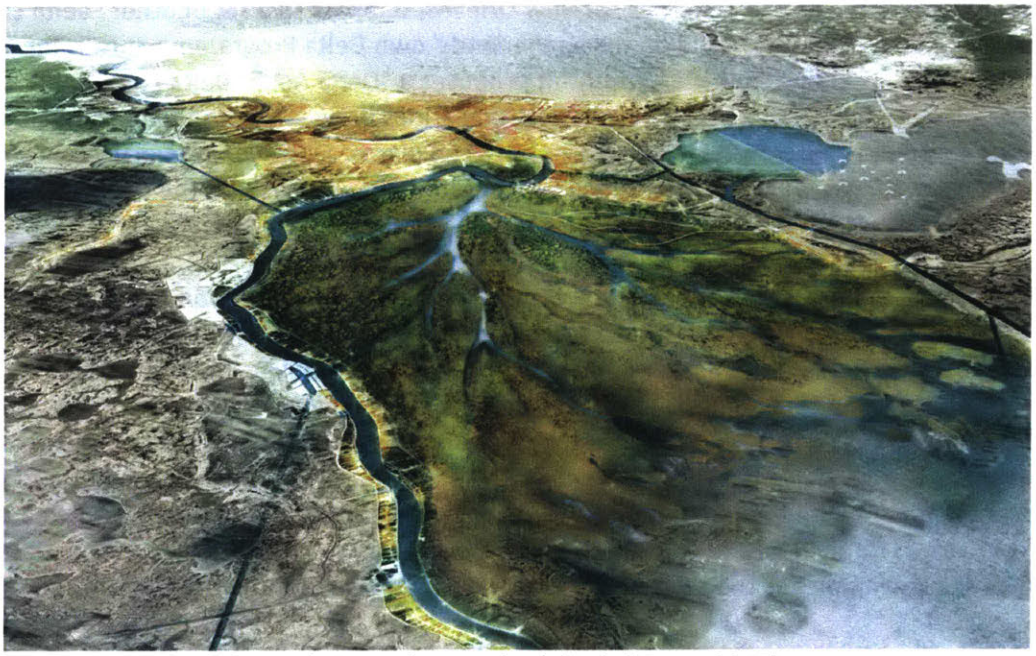

Figure 6.8. Visualizing the delta and city re-harmonized. (Baird Team 2015)

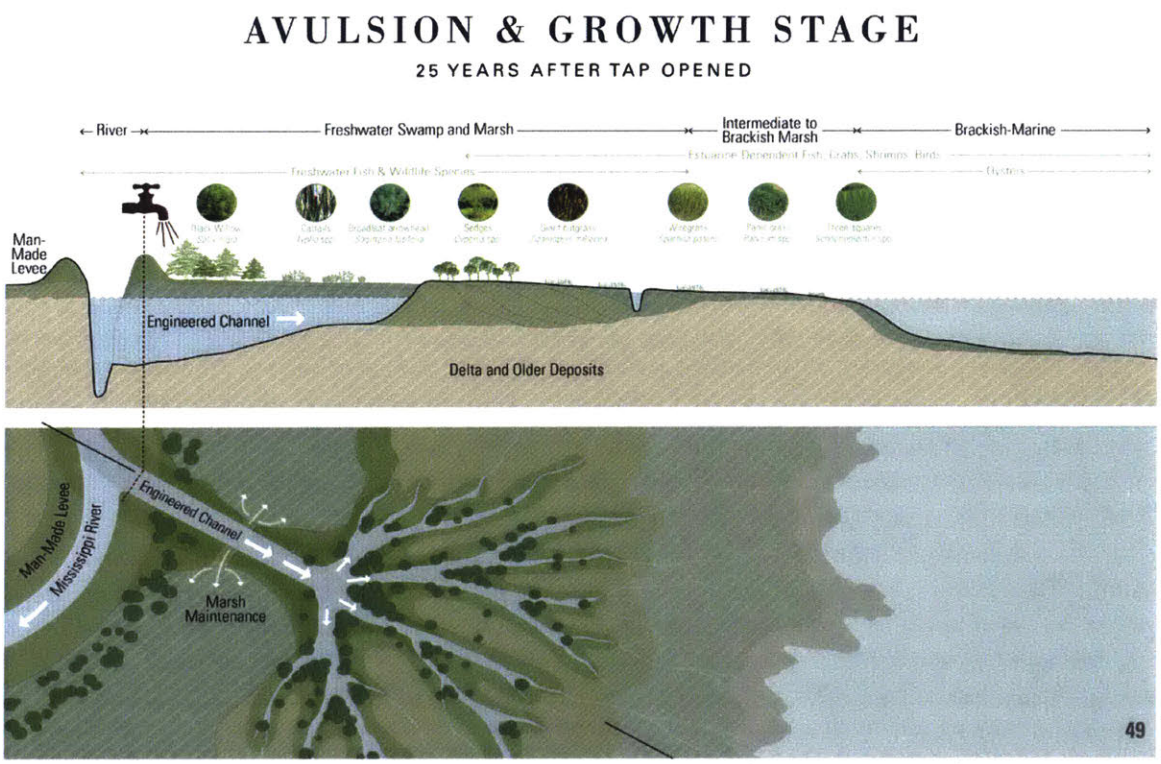

Figure 6.9. A restored delta with no sign of human habitation. (Baird Team 2015)

Foregrounding the geophysical similarities between deltas around the world may enable some amount of useful knowledge co-development and transfer. However, these cases also suggest that landscape essentialism can be used to justify the commercially-driven spread of problematic strategies. Though previous generations of levee urbanization in Dhaka and New Orleans demonstrate that substantially similar infrastructures in substantially similar geophysical settings can lead to dramatically different urbanization patterns (see Chapter 4), the invention of a class of "delta cities" has created a market for a standardized approach to Dutch water management. Grouping Rotterdam, New Orleans, and Dhaka together in a category labeled "delta cities" may in fact obscure as much as it reveals. The delta cities label suggests that in spite of the radical differences in these cities' urbanization and institutional contexts there is some essential underlying and immutable geophysical sameness that should drive their infrastructure and urbanization strategies.

In keeping with the rhetoric of landscape suitability and restorationism, many contemporary flood mitigation projects embrace a very different infrastructural aesthetics than that which characterized 20th century dry city infrastructures. 20th century floodwalls and levees were designed to be spatially and aesthetically distinct from both the 'natural' realm of the swamps and floodplains and from the urban environments that they were meant to protect and define (see Chapter 4). In contrast, contemporary proposals tend to be aesthetically aligned with either urban or natural conditions. Interviews with participants in recent projects suggest that this aesthetic makeover, coupled with new nature-tinged rhetoric, may contribute to the depoliticization of these projects. One New Orleans-based designer remarked that many new projects used terms like "berm" and "landform" to describe proposed new structural flood protections because the term "levee" was no longer politically popular. A longtime critic of Bangladesh's structural flood protections similarly observed that the Bangladesh Delta Plan used "all

these fancy new words," but in the end it would result in "the same old stuff... build more dikes" (Islam 2017). A Dutch engineer who has worked extensively on flood infrastructure planning in New Orleans explicitly connected this aesthetic and rhetorical shift to the use of the tools of design visualization, saying, "landscape architects are invaluable in visualizing how humans interact with these new structures. They are structures... just more natural looking structures" (Minns 2017). They went on to describe the political value of creating more natural looking, landscape-integrated projects, saying, "what we are giving people is more nature. We get less protest during public consultation" (Minns 2017). There are many compelling reasons for designing flood infrastructure to appear "more natural," including aesthetic, recreational, and ecological values. However, these comments from project participants suggest that invocations of nature in visualizations, in project aesthetics, and in rhetoric can also be used as depoliticizing branding for otherwise socially or ecologically problematic projects.

The internationalization of water-related design expertise may exacerbate the problems with this depoliticized approach to design. Following the example of the Netherlands, leaders in New Orleans and Dhaka have expressed aspirations towards developing flooding expertise as an "export product" (Netherlands Ministry of Infrastructure and the Environment 2016). *The Resilient New Orleans* strategy calls for the city to become a "global leader in urban resilience" (City of New Orleans 2015) and a recent article spoke of the city's aspirations to become "the Silicon Valley of water management" (Srinath and Plyer 2015). A recent article from a Dhaka-based climate change expert called for Bangladesh to look for ways of "profiting from adaptation to climate change" and to "sell ... adaptation knowledge" ("Profiting from Adaptation to Climate Change" 2017). As designers seek to join the growth industry of climate change adaptation expertise, it is essential to recognize that some types of expertise are easier to export than others. While attractive renderings of natural looking flood mitigation projects may help to sell projects around the world, the evidence from Dhaka and New Orleans suggests that these tools can also be used to promote heavy-handed mega-project interventions. A Dutch landscape architect who prized the designer's relational role as "a connector" spoke to the mega-project bias in the export of water expertise saying,

> Often there is an emphasis on the picture projects... the big infrastructure and these sorts of things... the other aspects, the connector functions, are harder to communicate, harder to export. (de Saalm 2017)

Another Dutch designer made a similar point in speaking of the efforts of government officials to promote Dutch water expertise, saying that they,

> [do] well with going around the world... to Asia and America to say the Dutch are a great example. But all of these international successes seem to be about engineers... Arcadis and these types. They are missing the integrative model. Somebody has to put all the pieces together. (Thomaesz 2017)

Putting the pieces together and acting as a "connector" requires deep relational understanding of local conditions and politics in ways that can be difficult for outsiders. On the other hand, the expertise to plan and built engineering mega-projects continues to be highly portable.

"Win-Win" Proposals

Like many contemporary climate adaptation proposals, recent flood planning projects in Dhaka and New Orleans embrace the conciliatory rhetoric of "no regrets" and "win-win" solutions. As in the case of invoking crisis-driven urgency and landscape suitability, the aim of developing "win-win" strategies with multiple benefits is not problematic on its face. However, as with these other features of contemporary flood planning projects, the rhetoric of "win-win" solutions becomes problematic when it obscures or quashes debate. In their analysis of the politics of coastal restoration projects in south Louisiana, Lewis and Ernston take issue with the pursuit of consensus, saying,

suggestions that 'everyone wins' in the implementation of large-scale infrastructure projects, "ecological" or otherwise, neglects the deep historical divisions, stubborn infrastructural embeddedness, ecological surprises, and territorial conflicts that permeate these initiatives (J. A. Lewis and Ernstson 2017).

Recent efforts including the Changing Course competition have used the tools of design visualization to advance this vision of "win-win" solutions in which, as the Baird team describes their proposal, there will be "positive outcomes for all stakeholders" (Baird Team 2015). The finalists' proposals feature collaged images showing seamless coexistence of many different interests and values on the same landscape, including the image referenced above that depicts heavy infrastructure, hunters, oystermen, and other users all inhabiting a restored marsh (Figure 6.3, above) (Moffatt & Nichol et al. 2015). The Baird team's final presentation took the "everyone wins" approach even further in a set of slides showing representatives of stakeholders groups with agreeable speech bubbles above their heads expressing their opinions of proposed infrastructural changes. Urban residents remark that they "don't notice anything different" and everything "seems about the same," while coastal residents and fishermen appreciate the plan too, saying "I can better plan for the future" and "I can keep fishing but maybe in different places" respectively (Figure 6.10) (Baird Team 2015).

While the aspiration to find solutions to complex problems that have no down sides is a noble one, the history of uneven distributions of costs and benefits from past flood infrastructure projects, not to mention the raging ongoing debates about proposed changes, suggest that these visualizations may be obscuring critical debates. As Groulx and Lewis identified in other settings, these Changing Course visualizations may be performing as "merely design marketing" "used to constrain public debate" rather than enable it (Groulx and Lewis 2017).

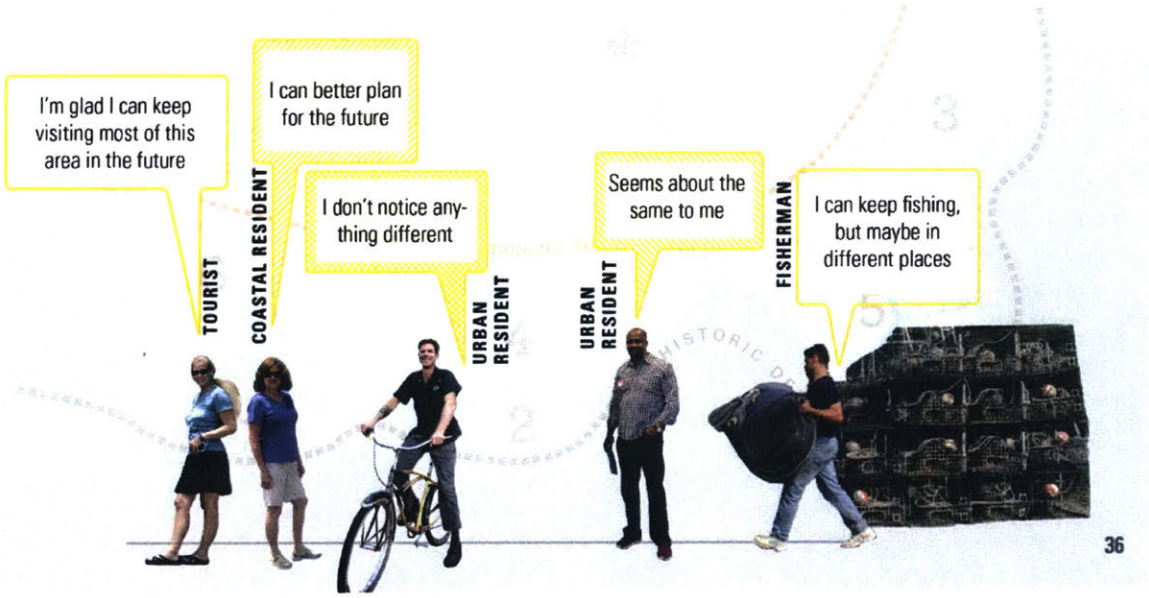

Figure 6.10. A 'win-win' and conflict free project. (Baird Team 2015)

The BDP *Urban Areas Strategy* includes renderings of "improved khals" or urban canals that again exemplify the use of design visualizations to make the case for spatial and infrastructural restructuring, without reckoning with their distributional costs (Figure 6.11). While "before" images show dirty water and the banks of the canals crowded with shed, "after" images show new floodable open space along sparkling blue water.

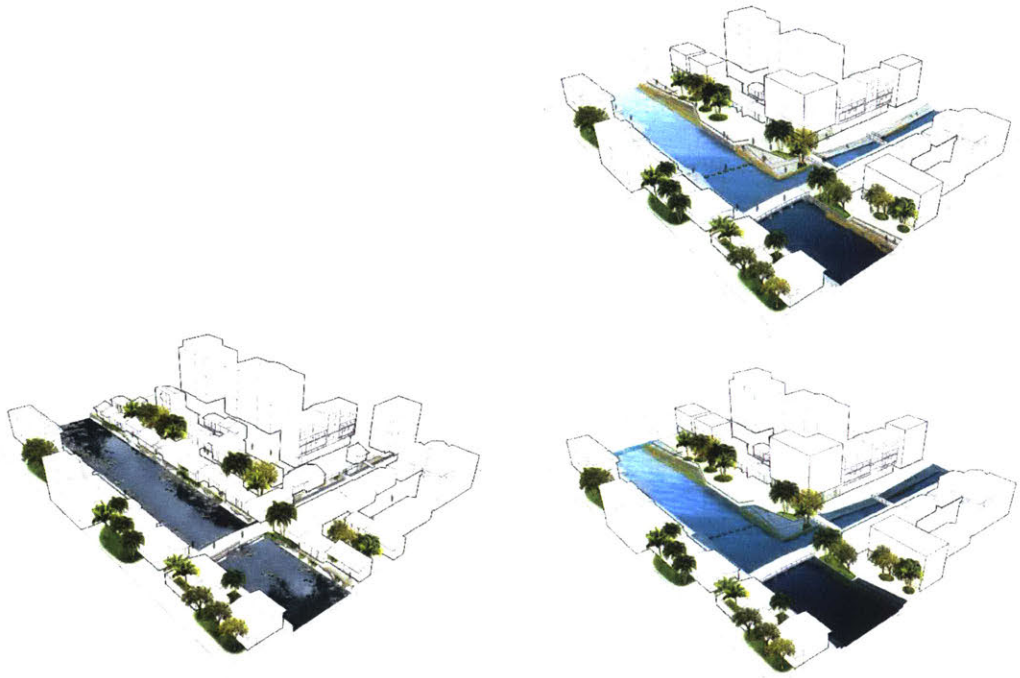

Figure 6.11. "Improved khals" from the BDP 2100 *Urban Areas Strategy* showing the removal of "encroaching" structures to create floodable open space.

The "improvements" in this case are largely in the removal of "encroaching" buildings. It is true that the presence of informal settlements along low-lying canals is problematic in terms of both the drainage functions of the canal and the flood vulnerability of settlements. However, in the context of Dhaka, "removal of encroachments" tends to mean, eviction and displacement of poor residents with no compensation or resettlement. Though the text of the report includes a parenthetical reference to "(resettlement in new low income building)," the Hatirjheel project and other examples of encroachment clearance have included little or no attention to compensation or resettlement. Much as previous generations of water infrastructure modernization projects in Dhaka and the wider delta, called for massive infrastructures whose proper functioning would have required complex and difficult governance and cultural shifts (see Chapter 3), these new projects again foreground the physical intervention without adequately attending to more complex action required to mitigate the projects unjust impacts.

As normative propositions, win-win projects, McHargian landscape suitability (the idea that settlements should suit their underlying landscape environmental conditions), restorationism (the embrace of pre-infrastructural modernization modes of building and settlement), and naturism (the embrace of the aesthetics of nature in flood infrastructure) are all appealing and grounded in sound reasoning. There is basic wisdom in considering how all cities might be more thoughtfully aligned with relevant environmental forces and better informed by vernacular building and settlement patterns. However, these linked impulses do not grapple with the thorny spatial politics that come with major spatial and infrastructural restructuring. To say that a city should return to earlier modes of settlement that were better suited to the environmental hazards of the landscape does not recognize the complex socio-ecological networks that make existing infrastructure configurations resistant to change and it does not

recognize the path-dependent dynamics that encourage the continued proliferation of unwise and unjust mega-projects {see Chapter 5). To undo these previous mega-projects would itself be a mega-project with the potential for dramatically uneven and unjust impacts. Design visualizations that depict imagined futures where delta cities have been re-harmonized with their landscapes too often implicitly or explicitly deemphasize the distributional consequences of this infrastructural revolution. With this willful blindness to the equity implications of adaptation, these proposals and visualizations can quite readily become tools for justifying damaging mega-projects.

These cases suggest that the tools of design and spatial planning can be used to create new justifications for projects that are likely to cause familiar problems. By invoking the aesthetic appeal of nature and the neutrality of the deltas' geophysical forces, delta landscape essentialism can naturalize proposals with major distributional consequences. By calling for a return to more harmonious modes of settlement, restorationism negates the claims and contestations embedded in place-specific and historically-evolved socio-technical levee complexes.

Conclusion

There is a tension between the universalism of conventional flood mitigation engineering and planning strategies and the context-specific and historically-contingent forces that shape urbanization. In both Dhaka and New Orleans, these tensions have invited conflict and debate as city leaders have sought to adapt their dynamic delta landscapes to enable urban expansion. Contemporary proposals in Dhaka and New Orleans promise a new paradigm for water management and flood mitigation that will answer the critiques of 20th century dry city infrastructures and address contemporary challenges, including climate change-linked flooding and uneven urbanization. In both cities, Netherlands-based water management experts have played a significant role in shaping these contemporary visions, aiming to replicate new Dutch water management practices identified with such labels as "room for the river" and "living with water." These recent projects enroll a wider array of disciplines than did the dry city projects of the past. Designers and spatial planners are among those professional actors who have gained a prominent place. Reports from participants and observers of these projects in the Netherlands, Dhaka, and New Orleans suggest that the tools of design and spatial planning may improve these processes, but that there is also cause for caution.

As discussed here and in Chapter 5, recent examples in both Dhaka and New Orleans illustrate the uneven distributional consequences and contestations that can come with major flood mitigation projects and proposals. Dhaka's Hatirjheel stormwater retention lake project displaced thousands of residents of informal settlements while allowing the headquarters of a powerful industry group to stay in its illegal site. The "Green Dot Map" galvanized planning-suspicious displaced New Orleans residents against post-Katrina "green spacing." The Louisiana Coastal Master Planning processes continues to be marked by acrimonious debate between state officials and scientists arguing for sediment diversions to rebuild the coast, and fishermen and residents in coastal communities who are suspicious that their livelihoods and communities are being sacrificed to save New Orleans.

Designers have powerful tools for synthesis and communication that can both enable and constrain the deliberations necessary to inform complex adaptation projects. In facilitating flood mitigation planning processes, "sloppy" design thinking and intentionally imprecise visualizations can play a catalytic role in enabling creative problem setting and cross-disciplinary synthetic reasoning. However, several participants and observers questioned these process values. They report that that too often designers underestimate the importance of in-depth disciplinary expertise. They observe that the efficacy of design visualizations is highly dependent on the receptivity of other participants to these methods. Even

as there has been a proliferation of international knowledge sharing and policy transfer related to urban flood mitigation, recent experience in Dhaka and New Orleans suggests that contemporary projects continue to undervalue local knowledge. Designers, in particular, appear to be widely unable or unwilling to grappling with the place-specific political deliberations that necessarily attend to these complex infrastructure and planning projects. Too often in these cases, designers have avoided engagement with political debate and conflict. In recent projects, designers have used visualization to actively ignore and conceal political contestation through a number of mechanisms, including: invoking crisis-driven urgency; reviving and sustaining widely discredited notions of techno-managerial neutrality; appealing to the presumed neutrality of landscape essentialism and restorationism; using the aesthetics of naturism to "sell" otherwise unpopular infrastructures; and supporting the rhetoric of "everybody wins" solutionism.

Decades of experience have shown that flood infrastructure mega-projects, rooted in universalizing techno-managerial knowledge, often lead to unwise and unjust outcomes. Many contemporary projects position designers and spatial planners as central to developing a new paradigm of flexible, adaptive, and integrative planning. However, the examples of recent projects in New Orleans and Dhaka suggest that, for design and planning to fulfill these ambitions, practitioners will need to engage rather than shrink from political contestations and deliberations. If designers do not find ways of expanding their "sloppy thinking" to engage with messy politics, they are likely to be limited to producing "design marketing" for damaging mega-projects.

CHAPTER 7
Designing Flood Mitigation and Adaptation for Cities As They Are: Synthesis and Implications

From the earliest urban settlements, controlling the flow of water has been central to urbanization. For millennia, levees, dams, canals, reservoirs and other water infrastructures have enabled and constrained the uses of space, shaping settlement patters, economies, and politics. As cities around the world reckon with the uncertainties of climate change-linked flood hazards and uneven socio-spatial development, water management infrastructures are again taking a central place in debates about the future of urban space and life. These contemporary adaptation efforts are shaped, not only by shifting geophysical landscape dynamics, but also by the embedded and accumulated patterns of space and politics created by previous generations of infrastructure development and the urbanization that they have enabled. Previous attempts at large-scale flood mitigation, particularly 20th century dry city infrastructures, have been widely blamed for a host of unwise and unjust outcomes. This study has asked:

> *To what extent are emerging practices in urban flood mitigation unsettling the patterns of past generations that led to unwise and unjust outcomes? How are the tools of design enabling or constraining transformative adaptation?*

In this final chapter, I briefly recount the central findings and offer recommendations based on the arguments outlined in the previous chapters. I then discuss the study's limitations before closing with synthetic observations for future practice and research.

The Emergence, Evolutions, and Limitations of Dry City Infrastructural Modernization

In Chapter Two and Three, I recount the emergence, evolution, and discrediting of dry city infrastructural modernization in New Orleans and Dhaka. By the end of the 20th century, both of these very different cities had constructed substantially similar systems of encompassing structural flood protections (earthen levees and floodwalls) and mechanical pumped drainage. The process and timing with which each city arrived at these systems was very different. Where New Orleans was dependent on structural flood protection from its very earliest days as a colonial outpost, Dhaka largely relied on non-structural strategies for avoiding flood risk until the late 20th century. Throughout most of the city's four hundred years of history, its lack of substantial structural flood protection levees meant that most of Dhaka's structures were either impermanent or were confined to a ridge of relatively high and stable ground.

Both cities' 20th century dry city infrastructures align with what Kaika calls the "Promethean project of modernization," harnessing landscape forces to enable urbanization and accumulation (Kaika 2004). These projects were justified using a wide range of rationales. In both cities, advocates promoted levees as a means for state entities to exercise control over urban growth. Levee boosters in New Orleans argued that their projects would promote growth and modernize the city by enabling new suburban districts and public infrastructures. In Dhaka, domestic hydrocracies and international development consultants argued that dry city infrastructures would provide a means of disciplining and ordering growth in a city frequently presented as chaotic.

In both cases, the development of dry city infrastructures was shaped by the emergence of national-level hydraulic bureaucracies tasked with mobilizing modern science and engineering to advance a particular vision of state-led modernization and growth (Molle, Mollinga, and Wester 2009). The hydrocracies of East Pakistan (EPWAPDA) and later Bangladesh (BWDB) were modeled after precedent institutions in the USA (e.g., USACE and TVA) and the Netherlands (e.g., the Rijkswaterstaat). Beginning soon after the end of colonial rule in the eastern Bengal delta, officials and private contractors operating through new development institutions like the UN and the World Bank, spread the gospel of water

infrastructural modernization through "missions" in East Pakistan (United Nations Water Control Mission 1959; EPWAPDA and IECO 1964). These water infrastructure evangelists were part of a larger group that a 1954 *Time* magazine cover labeled as "Ambassadors with Bulldozers."

The 20th century Promethean projects to construct Dhaka and New Orleans' dry city infrastructures, broadly fit a model of what Graham and Marvin call the "modern infrastructural ideal" (S. Graham and Marvin 2001), meant to provide "comprehensive" services to urban territories on a theoretically even basis. However, in both Dhaka and New Orleans dry city infrastructural modernization was contested, episodic, crisis-driven, and uneven. In both the Mississippi and Bengal deltas, as early as the mid-19th century critics raised alarm at the dangers of levees and the modes of urbanization that they enable. In both cities, prominent 20th century planners (e.g., Patrick Geddes in Dhaka and Ian McHarg in New Orleans) produced alternate visions for urbanization and settlement patterns that were not premised on binary separations of land and water, city and swamp. Nonetheless, the highly path-dependent process of dry city infrastructural modernization marched forward in both cities as levee boosters promised a 'permanent solution' to the 'flooding problem.' In both cases, advocates of conventional structural flood protection invoked a sense of crisis-driven urgency following episodes of flooding to rally support for levee and pump projects. Though encircling levees and pumps provide theoretically even levels of protection from flooding to all territories within their encompassing embrace, because of micro-topographical differences, chronic challenges of maintenance and operations, and acute dangers from catastrophic failure, their flood mitigation has proven to be highly uneven.

During the final quarter of the 20th century, conventional dry city infrastructure projects were the subject of strong critiques in both the Bengal and Mississippi deltas. Some critics focused on the *unwise* implications of heavy-handed structural flood protections, arguing that levees and pumps create a variety of unintended negative social and environmental consequences. These dry city infrastructures were also widely critiqued as unwise insofar as they increased rather than decreased flood vulnerability by hiding flood risk and encouraging building and urbanization patterns that were not well adapted to flood risk. This phenomenon of unwise levee-enabled growth is known as the *levee effect.* Dry city infrastructures have also been shown to be deeply unjust in that their costs and benefits are radically unevenly distributed. In both their construction and in their implications on urbanization, levees and pumps support the material interests of particular politically empowered constituencies, including real estate developers, land owners, hydrocracies, and engineering and construction firms. In the process, these interventions harm groups who rely on common pool resources and nature-based livelihoods, which are disrupted or destroyed in the process.

In light of these criticisms of levees as unwise and unjust and broader trends towards neoliberal state retrenchment, flood mitigation strategies evolved substantially in both Dhaka and New Orleans. In spite of major territorial growth of both cities' urbanized areas, neither has enlarged its empoldered territory since the late 20th century. The last major levee expansions were the post-Hurricane Betsy levee expansions of the 1970s and 80s in New Orleans and the FAP embankments of western Dhaka in the early 1990s. In both cities, much of the recent urban growth has taken place in areas outside the levee-protected zones, relying not on collective state-led flood protection infrastructure, but on privatized forms of risk mitigation including widespread landfill-based urbanization in Dhaka and house-by-house elevation and subsidized flood insurance in New Orleans. While this shift from collective protection via levees and pumps to privatized flood risk reduction avoids some of the pitfalls of levee-enabled urbanization (e.g., no threat of catastrophic failure and no levee effect), it also brings some troubling impacts. Privatized flood risk mitigation provides benefits to only those residents who can afford to buy or rent improved properties. Landfill based urbanization also comes with many negative social and

environmental consequences including destroying existing hydrological conditions and livelihoods and displacing flood risk onto other areas.

Understanding these place-specific and historically-contingent processes by which Dhaka and New Orleans came to embrace and subsequently question their dry city infrastructures provides critical insights for making sense of contemporary landscapes of uneven risk. Each city's pattern of historical dry city infrastructure has created path-dependent patterns of growth that exert profound influence on contemporary and future urbanization processes. The process of international transfer of policy, knowledge, and ideology that linked levee development in New Orleans and the USA to infrastructural modernization in Dhaka and Bangladesh is also a crucial antecedent to ongoing processes of internationalized transfer of water management 'best practices' from the Netherlands to both sites. While the contemporary renewal of state-led flood mitigation holds potential for redressing problems that beset 20th century infrastructural modernization, these efforts will have to reckon with the complex legacy of previous generations of infrastructure and the patterns of urbanization that they enabled.

Levee Complexes: Urbanization of Infrastructure

In Chapter Four, I examine how the dry city infrastructures built over the course of the 20th century in Dhaka and New Orleans have become enmeshed in complex socio-technical ensembles or levee complexes. These levee complexes impact urbanization in dramatically different and frequently unexpected ways. Though the systems of levees and pumps built in Dhaka and New Orleans were similar in their design and planning, and in the expectations for how they would impact their cities, the way the infrastructures were urbanized was radically different. Though they were conceived and designed using a universalizing techno-managerial logic, once in place, the levees became part of context-specific levee complexes that include other engineered systems, spatial governance regimes, and informal social expectations. The form, composition, and dynamics of these complexes is shaped by historically contingent, place-specific, path-dependent processes.

Recognizing this tension between the universalizing assumptions of infrastructure design and the context-dependent processes by which levees are urbanized, I have several recommendations. First, the design of urban flood mitigation strategies should be informed by deep study of historical urbanization patterns and a realistic appraisal of existing and expected engineering, financial, and governance capacities. Many of the most unjust and unwise consequences of dry city infrastructural modernization in both Dhaka and New Orleans can be attributed to overly optimistic, simplistic, and flawed assumptions regarding how those infrastructures would shape urbanization through their impacts on human and natural systems. Levee boosters with epistemological, professional, and material interest biases, used moments of crisis-driven urgency to advance projects with promises of inflated benefits and de-emphasized costs. They overestimated the ability of these infrastructures to provide reliable protection and to spur and guide urban growth. Meanwhile, they underestimated the challenges of uncooperative natural systems (e.g., subsidence) and human systems (e.g., reduced adaptation and unexpected spatial and demographic shifts).

Second, structural interventions that require major changes or improvements to non-structural systems should not be built when there is serious doubt about the capacity to implement the non-structural components. Levee boosters in Dhaka and Bangladesh have repeatedly justified muscular structural flood protection interventions with unrealistic assumptions about the capacity of state actors to deliver critical non-structural changes. Dhaka's dry city infrastructures of levees and pumps were designed to require the permanent protection of large areas for stormwater retention ponds and canals. Given the extreme demographic pressure and severe limitations on financial and spatial governance capacity in

Bangladesh, the assumption that the state could effectively restrict settlement was unjustified and unwise. The problems with these project assumptions would have been readily apparent had project designers realistically appraised the recent history of flood control infrastructure and spatial governance, as exemplified in the rapid urbanization of the DND area once embanked in the 1960s. Instead, a mega-project coalition of international consultants and domestic political leaders went ahead with a project whose success was premised on an unrealistic expectation that the city's spatial governance could be radically reformed without funding or planning those reforms.

Finally, levees must be designed with an appreciation of the complex ways that they will operate spatially as they are enmeshed in socio-technical networks. Even recognizing the many ways in which structural flood protections have proven unwise and unjust in the past, the inertia of past investment and the amplification of flood risk due to climate change will undoubtedly require the design and construction of more such protections in the future. In both appraising the historical development of past flood infrastructure projects and designing new projects, it is critical to recognize that linear structural flood protections like levees do not simply operate as binary barriers between different hydrological and urbanistic realms. Much of the literature on levees focuses on their boundary function, defining inside from outside, wet from dry. While this *boundary* function is a crucial component of how levees produce and transform urban space, it is integrally tied to the other spatial registers on which levees operate, those of the *object*, the *site*, and the *corridor*. First and, perhaps most obviously, levees are physical *objects* with specific material and spatial configurations that may hold symbolic and associational meaning as well as functional implications. Next, levees operate as *places* or *sites* on which other activities and constructions can take place. They can also operate as *corridors* of connection. To understand how levees function within spatially dynamic socio-technical ensembles (Bijker 1995) and how these ensembles generate persistent urban patterns, it is essential to consider this range of spatial functions. This four part framework for the spatial registers of levees takes as a precedent Kevin Lynch's five features of urban space (node, path, edge, district, and landmark) (Lynch 1960). Like Lynch's five features, the four-part framework for the spatial functioning of levees provides a finite structure within which to assess and account for the richness and complexity of the experience of urban space.

To analyze existing levees or design new levees with these four spatial mechanisms in mind is to recognize that levees do not simply divide city from swamp, wet from dry. Rather, in their object dimension, the form and materiality of levees shape how people, plants, and animals interact with them. In New Orleans, the levees' height shapes how high residents elevate their homes. In Dhaka, people build shops perched on the shoulders of levees, carve into their bases to provide walking paths, and pierce through them to run sediment pipelines for landfilling operations. In their site and place dimension, levees frequently become symbolically important places. In south Louisiana, the symbolic site value of levees makes them attractive as sites for a range of uses and activities including, hosting the USACE's district headquarters offices, Mardi Gras parades, and annual Christmas bonfires. In Dhaka, levees have become sites of enormous activity from riverfront commerce and roadside cafes to memorials for victims of government violence during the independence struggle. The ability of levees to operate as corridors has also significantly shaped their function and evolution in both Dhaka and New Orleans. While New Orleans' levees operate as corridors for recreational bicyclists and dog walkers, in Dhaka the levee-top road has become a major thoroughfare in a traffic-choked city, significantly contributing to the evolution of the levee into a spine of urbanization. Thus, it is critical that not only do levee designers consider spatial functions beyond their boundary function, but also that they consider how these four spatial mechanisms interact with one another.

On the Return of Flood Mitigation Mega-Projects

In Chapter Five, I analyze recent and ongoing flood mitigation planning and infrastructure projects in Dhaka and New Orleans. Responding to invocation of climate and urbanization crises, project boosters are again calling for major state-led flood mitigation efforts. Given the widespread critiques of previous generations of dry city infrastructure projects as unwise and unjust, many contemporary proposals are presented as bringing a "new paradigm" of urban water management. The projects use methods described as 'horizontal,' rather than 'vertical,' 'open,' rather than 'closed,' 'green,' rather than 'gray.' Many of these projects are shaped by direct input from experts from the Netherlands, who have, in recent years, more aggressively sought to market water and flooding expertise as an 'export industry.' These projects are often identified with such conciliatory labels as 'living with water' and 'room for the river' and draw inspiration from recent high-profile efforts to shift Dutch water management practices away from heavy-handed structural interventions and towards multi-functional, flexible, landscape-based projects. Boosters of these projects often embrace the principles of McHarg-influenced 'delta urbanism,' seeking to repair damage done by previous generations of infrastructure and restore connections between settlements and their landscapes. They promise a shift from infrastructures that forcefully control natural processes to infrastructures that work with those processes.

Through interviews with participants and observers and analysis of planning documents, I found that these new projects are, for the most part, falling short of their promise of delivering a new, less controlling paradigm of water management. I found that existing infrastructures and the settlement patterns that they enabled are deeply obdurate, resistant to change. Further, I found that--even as planners, designers, and city leaders embrace the rhetoric of nature-based flood mitigation--many of the projects being undertaken today continue to promote conventional dry city infrastructures. Despite changes in rhetoric, many of the path-dependent dynamics that promoted previous generations of dry city infrastructures remain in place. In particular, the embedded professional epistemologies of project-based simplification, abstraction, and quantification persist in contemporary projects. Similarly, many actors with entrenched material interests in 'big engineering' projects continue to exercise significant influence. Even when the strategies employed in new projects depart significantly from past dry city approaches, those earlier generations' biases persist, suggesting that unwise and unjust outcomes may persist as well. Recent proposals and projects from the post-Katrina "Green Dot Map" in New Orleans to the Hatirjheel stormwater retention lakes in Dhaka, suggest that contemporary flood mitigation efforts are likely to be beset by contestation over the uneven distribution of project costs and benefits. Though contemporary proposals to remake water management in Dhaka and New Orleans and their respective regions' would bring dramatic spatial restructuring with serious equity implications, these proposals frequently de-emphasize or obscure the political contestation that accompanies such disruptions.

In light of the obduracy of previous generations of dry city infrastructures and the persistent bias towards big engineering flood mitigation, I recommend the following changes. First, it is essential that any future flood mitigation interventions be undertaken with a clear understanding of how previous generations of projects have shaped the physical and political landscape. Dry city infrastructures create deeply path-dependent patterns of urban development that cannot be simply and easily restructured. Thus, even as our understanding of the impacts of those previous projects evolves, flood vulnerable cities and landscapes cannot be seen as tabula rasa on which to enact projects befitting changing flood mitigation 'best practices.' While dry city infrastructures were promoted on the basis of technical neutrality and efficiency maximization, these previous projects shaped hydrological, urbanistic, and political conditions in radically uneven ways. Just as much as their impacts on physical urban patterns and hydrology, the political legacy of previous projects -- perceived slights, biases, suspicion, and distrust -- must form the starting point for any planning for future projects. These patterns of

historically-embedded spatial politics should be treated as a site condition, just as climate, hydrology, and topography are today.

Given the contentious legacy of past flood mitigation infrastructure, popular deliberation must be considered co-equal with the technical aspects of flood mitigation projects. Future flood mitigation planning processes must account for both the persistent epistemological biases and entrenched material interests that have favored damaging 'big engineering' approaches in the past. To counter the persistent epistemological biases towards modeling, quantification, abstraction, and simplification, planning processes should be opened up to a much wider range of forms of knowledge. There is a particular need to develop strategies to incorporate ways of knowing, representing, and measuring places that are not readily incorporated into dominant professionalized planning processes. This means taking seriously what James Scott calls *metis,* or embedded experiential knowledge of landscapes and places (Scott 1998). It means inquiring into and observing how people and landscapes have reacted to previous flood mitigation interventions, especially when those emergent patterns have not conformed to the expectations of project planners and designers.

Just as the persistent epistemological biases of previous projects must be acknowledged and intentionally counterbalanced in future flood mitigation, so the entrenched material interests that have so effectively promoted 'big engineering' approaches must also be acknowledged, accounted for, and countered. State hydraulic bureaucracies, private engineering and construction contractors and consultants, financial institutions, and real estate interests all have substantial material interests in promoting mega-projects. These mega-projects may be conventional dry city infrastructures like levees and pumps or 'new paradigm' approaches labeled with conciliatory and agreeable terms like 'living with water' or 'room for the river.' Participants in the Changing Course competition in South Louisiana reported with alarm that, though the project was promoted as advancing 'out of the box' long term visionary proposals, the competition's structure gave disproportionate influence to major construction and engineering firms, who pushed proposals towards strategies that would deliver major contracts in the future. Similarly, massive dredging contractors have been central to advancing new Dutch water management practices in the Netherlands following new regulatory restrictions on conventional infrastructure practices (de Vriend and van Koningsveld 2012). These Dutch dredgers are now among the most aggressive promoters of exporting Dutch water management abroad, including in Bangladesh, where building "dredging business partnerships" between large Dutch companies and Bangladeshi companies was promoted as a "potential win-win on land development" (Bergh, Bucx, and Guchte 2012). Perhaps, not coincidentally, the Dutch-funded Bangladesh Delta Plan 2100 recommends major investments in projects that would benefit dredging firms, including both ambitious land reclamation based development and continuous dredging of waterways (Bangladesh Planning Commission 2017).

It is entirely possible that equitable and environmentally sustainable flood mitigation in these deltas will include land reclamation and waterway dredging. It is also likely that any major flood mitigation and adaptation efforts will include experienced contractors and consultants. However, it is essential to recognize that these firms' profit motives introduce bias that may run against the public interests. For instance, an early proposal for Dutch-Bangladeshi dredging partnerships explicitly recommended a partnership with the Bashundhara Group. While the Bashundhara Group does indeed have experience in land reclamation for urban development, they are also widely regarded as a 'mafia-like' enterprise whose own urban development projects have been enabled by campaigns of political influence and violence against peri-urban peoples (see Chapter 4). If such powerful groups with entrenched material interests are to be involved in future flood mitigation efforts, it is essential that their interests be transparently recognized and that their biases be countered with other perspectives.

The Design-Politics of Flood Mitigation in the Age of Climate Adaptation

In Chapter Six, I assess the role of designers and spatial planners in this recent resurgence in state-led flood mitigation planning in Dhaka and New Orleans. I find that, with the inspiration and direct influence of Dutch water experts, the tools and methods of design and spatial planning have gained an increasingly central role in ambitious urban flood mitigation planning and infrastructure projects. Where the universalizing techno-managerial logic of civil engineering dominated in previous generations, these recent efforts promise greater flexibility, more sensitivity to socio-ecological context, and greater attention to delivering multiple benefits beyond flood mitigation. To deliver on these ambitions, these projects widen the scope of disciplinary knowledge brought to bear and frequently place design and spatial planning in central positions of coordination and synthesis.

Though participants and observers of these recent efforts in Dhaka and New Orleans widely share the view that design and spatial planning offer important tools for improving flood mitigation planning, they also raised some areas of concern. Many celebrated the contributions of design and spatial planning in improving processes, products, and communications. In the realm of process, observers celebrated the capacity of 'sloppy' design thinking and process visualization methods to create new creative modes of 'problem setting' and cross-disciplinary synthesis. They regarded spatial planners and designers as central to creating interventions that deliver on multiple non-flood mitigation benefits, including: aesthetic beauty, connection to natural and cultural context, and legibility. Many said that the tools of planning and design enabled these processes to better communicate complex and dynamic problems and projects through a range of mechanisms, including: creating catalytic visions; constructing compelling narratives and generative metaphors; and educating the public regarding project tradeoffs.

While participants and observers nearly universally praised efforts to widen the range of disciplinary knowledge in urban flood mitigation projects, several people raised serious concerns regarding the contributions of planning and design. Some observed that designers under-estimated the importance of disciplinary knowledge and promoted superficial projects and unproven strategies. The experience in Dhaka and New Orleans also suggest that the efficacy of design visualizations in enabling cross-disciplinary synthesis is highly dependent on the receptivity of project players from other professional and international cultures. This context-sensitivity of design methods is especially important given the increasing internationalization of water-related design expertise.

The recent Dhaka and New Orleans cases also suggest that there are some serious concerns regarding the role of design in communicating these ambitious water projects to the public. In both cases, it appears that the persuasive tools of design visualization have been deployed as "design marketing" (Groulx and Lewis 2017) to depoliticize projects with potentially serious distributional and equity impacts. The mechanisms through which these depoliticizing visualizations operate include: invoking crisis-driven urgency; foregrounding the supposed neutrality of geophysical landscape essentialism and restorationism, which promises to restore balance and connection between urban and natural landscapes; strategically embracing more 'natural-looking' infrastructures which are functionally similar to conventional interventions; and promising 'win-win' strategies in which massive landscape scale restructuring can be achieved with no significant uneven costs.

Each of these depoliticizing mechanisms of design communication are grounded in rational and well-intentioned normative propositions. Indeed, there is a need for greater urgency in responding to the mounting vulnerabilities associated with climate change. Nuanced understanding of geophysical dynamics and pre-modernization precedents should inform urban infrastructures and settlement

patterns. Building "natural-looking" infrastructures can provide many legitimate values including ecological functioning and human enjoyment. And of course, flood mitigation interventions should be designed to provide multiple benefits to different groups.

The problems come when these techniques are used in support of projects that remain constrained by the same persistent abstracting techno-managerial epistemologies and entrenched material interests that have produced unjust and unwise flood infrastructure mega-projects in the past. When designers use their powerful tools of synthesis and persuasion to rush past, ignore, or conceal the conflicts and contestations that are likely to come with flood mitigation and adaptation projects, they are likely to be enrolled in support of destructive mega-projects that reproduce these problematic patterns of the past.

The tools of design and spatial planning offer powerful potentials for improving urban flood mitigation through synthesis and persuasive visualization and communication. Visual communication is likely to become only more pervasive in planning as in other modes of communication in the future. The thorny spatial politics of climate adaptation will require planning and design interventions at a range of scales to reconcile the demands of risk mitigation with other urban values. However, without adequate attention to the equity implications of these projects, there is a real danger that these tools will be put to use in justifying mega-projects with deeply unjust implications. In one particularly egregious example of the uneven impacts of recent flood mitigation projects, thousands of poor residents were displaced without compensation or resettlement to make way for Dhaka's Hatirjheel stormwater lake project while a powerful industry group was allowed to stay in their illegal building for more than a decade.

To maximize the positive potentials and minimize the dangers, I recommend the following changes to how designers engage in complex urban flood adaptation projects. First, designers and other participants in these projects must develop a more sophisticated understanding of the political power of the representational tools of design in adaptation planning. Design visualization is an act of rhetorical persuasion and therefor an act of design-politics. A potent vision for alternative futures can catalyze action, elevating some perspectives and obscure others. These visualizations are not politically neutral. Therefore, the designers producing visualizations must be trained and sensitized to interrogate which perspectives they are elevating and which they are ignoring or obscuring. The hunger of designers and spatial planners to play a meaningful role in urban adaptation must not lead them to ignore crucial questions of the epistemological biases and material interests that their work represents.

Second, designers and spatial planners should contribute to pluralistic adaptation by seeking out and creating opportunities to work with a diverse range of groups with an interest in urban flood mitigation and adaptation. While national, state, and local government entities are important brokers in supporting and guiding flood mitigation planning processes, these groups and the planning processes that they oversee are also frequently deeply constrained by the path-dependent patterns of past infrastructure and planning decisions. To overcome or counter this inertia, planners and designers must both work to change these state-led processes to make them more open to a wider range of forms of knowledge and interests and create alternative loci of 'insurgent' (Miraftab 2009) or counter planning action. Whether working within conventional state-led planning processes or through insurgent or alternative planning actions, designers and planners must develop tools for more directly, honestly, and transparently grappling with the thorny spatial politics of adaptation. They must not shrink from or minimize the equity implications and contestations likely to come with major interventions in urban settlements and infrastructures. Rather, they should use their tools of synthesis and communication to facilitate debate and democratic deliberation.

Finally, designers and spatial planners must resist the urge to invoke crisis-driven urgency to motivate actions in areas that are politically contentious, characterized by significant uncertainty, and likely to have substantial, long-term impacts. Mitigating the extent of future climate change by reducing greenhouse gas emissions is an urgent matter with serious intergenerational and socio-economic equity implications. Urban adaptation, including flood mitigation, also has serious equity implications and requires timely action. However, too often the "apocalyptic imaginaries" of the climate crisis "evacuate dissent" and deemphasize the differential responsibility for and likely impacts of climate change (Swyngedouw 2010). With their powerful tools for visualizing alternative futures, designers and planners are well positioned to invoke crisis-driven urgency. However, they should use this capacity sparingly, focusing instead on using their tools and methods for enabling debate and deliberation by working with diverse groups to create pluralistic visions for adaptation futures.

Study Limitations

This study attempts to illuminate evolutions in the politics of urban flood infrastructure and planning. The research design bridged between areas of inquiry that are frequently treated as incommensurable: cities of the Global North and South; historical and contemporary planning; and planned and emergent urbanization processes. Bridging each of these methodological divides offers opportunities for new insights. However, the applicability of some of the study's findings is necessarily limited.

Case Selection

As with any case study research, there is the question of to what extent these particular cases represent broader patterns or trends that might be relevant in other cities. Because of their locations in flat, low-lying, and flood prone delta landscapes, Dhaka and New Orleans are both characterized by a tighter coupling between flood infrastructure development and urban growth than is the case in other cities where topographic relief plays a more determinative role in flood vulnerability. Nonetheless, the fact that the historical development and contemporary planning in these two very different cities share some common patterns may suggest useful starting points for research in other coastal and river delta cities. Likewise, the points of radical departure in how Dhaka and New Orleans' levees have been urbanized indicate a need for more research into place-specific, historically-contingent urbanization processes. It is the tensions between these context-specific dynamics and universalizing logics of global best practices in planning, design, and engineering that are likely to lead to unjust and unwise outcomes. Therefore, inquiry into different pairings of cities with similar hazard profiles and infrastructural configurations may well have led to different findings, but they would be unlikely to fundamentally challenge the insights gleaned from this study.

The choice of conducting research across the North-South divide also brought logistical limitations and struggles. Because comparable statistical data between Dhaka and New Orleans are not available, the project largely avoided direct quantitative comparisons. It is likely that with improved data, spatial statistical analysis could yield new insights about the relationship between flood infrastructure and urban growth. Similarly, there were other data types that were not directly comparable between the two cities. While municipal government and academic institutions hold extensive archives related to New Orleans historical planning and infrastructure development processes, parallel archives in Dhaka are generally not available. While there are extensive records from the British colonial era in Dhaka, the archival records of the East Pakistan and Bangladesh eras are less complete and less accessible.

Point in Time

This study engages with issues of urban climate adaptation that are emergent and dynamic. At the time of this study, Dhaka and New Orleans had each undertaken some ambitious water management

projects, while other planning projects were still in process. In Dhaka, the Netherlands-sponsored Bangladesh Delta Plan 2100 was still being finalized at the time of the fieldwork and writing of the study. The ongoing nature of the project offered advantages in allowing me to interview participants and observers while the project was still fresh in their minds. However, it also limited my access to some critical documents and limited my ability to comment on the project's final outcomes since the final reports and recommendations were not yet released. Similarly, at the time of the fieldwork in New Orleans there were promising developments underway with the Gentilly Resilience District and the LA SAFE adaptation planning process in adjacent parishes. While these ongoing processes informed my inquiry, I did not directly or substantially engage with them because of their preliminary status at the time of the study.

Future Directions and Possibilities

I close with a brief recounting of some of the cross-cutting themes that have emerged from this study before highlighting some positive possibilities emerging from planning and design in Dhaka and New Orleans.

Multi-City Relational Case Study Research and the Globalization of Flooding and Adaptation Knowledge

This study used a two city transnational case study research design focused on Dhaka and New Orleans, two cities that radically differ in many dimensions of urbanization, but share similar flood hazard profiles and infrastructural configurations. By viewing these two very different cities in relation to one another, the study follows Ananya Roy's call to "use one site to pose questions of another" to unsettle entrenched lines of questioning (Ananya Roy 2003). The two case design allowed me to both reveal new dimensions of the individual cases and to observe the impacts of transnational flows of information, capital, and professional expertise linking these two cities both directly and indirectly. Following Vanessa Robinson's call for comparative urban research across the "global North-South divide," (Robinson 2011) the two case pairing allowed me to see New Orleans "from the South" (Watson 2009) and to interrogate the ways that ill-fitting "Northern" infrastructural and planning practices have unfolded in Dhaka. While informal urbanization is a regular topic of research in cities of the Global South, there is relatively little research on the role of emergent urbanization patterns in shaping uneven urbanization in the USA. By testing established structural and behavioral models of vulnerability production against empirical research findings in both cities, the study reveals that in New Orleans, no less than in Dhaka, unanticipated emergent social and natural processes modulate the impacts of levees on uneven urbanization and vulnerability production. Viewing Dhaka and New Orleans in relation to one another also revealed some common patterns related to the emergence and discrediting of dry city infrastructural modernization and the contemporary resurgence of state-led flood mitigation after a period of neoliberal "splintering" (S. Graham and Marvin 2001). By tracking the historical linkages between dry city infrastructural modernization in the Mississippi and Bengal deltas, the study highlights that the contemporary spread of Dutch water management expertise is only the latest instances of a long history of knowledge transfer in the water and flood mitigation sectors. This historical perspective suggests that, in spite of the credulous and laudatory tone of much of the work on contemporary Dutch water management, there is a need to critically assess the motives and impacts of such policy mobility (Peck 2011) projects.

Infrastructural modernization has long been an international project. French military engineers established standard practices of levee building used in the lower Mississippi delta. Innovations in pumping technology developed by an engineer in New Orleans in the early 20th century were adopted in the Netherlands. The "Ambassadors with Bulldozers" brought their brand of post-World War II Euro-American engineering interventionism to the eastern Bengal delta. The proliferation of Dutch water

management in Dhaka, New Orleans, and other flood-prone cities around the world continues and expands on this pattern. Given the historical pattern of imported technologies, practices, and epistemologies creating unforeseen problems when applied in different urbanization contexts, these contemporary imported practices should be scrutinized closely. Past experience shows that the impacts of major flood interventions are shaped by the specific conditions of their physical and political contexts. However, the threat and political mobilization around climate change has only increased the internationalization of expertise and finance. Many of the same experts and consultants are employed on urban water management projects around the world. This tension, between the hyper-local dynamics that shape urbanization and the increasing internationalization of expertise and finance will require the development of new methods for bridging and translation. While many participants and observers interviewed for the study suggested that designers and spatial planners are particularly well equipped to serve this translating function, it is clear that this relational function can be especially challenging for outside practitioners without deep contextual knowledge. If they are not able to fulfill this connector function, outside designers risk lending their persuasive powers to mega-projects that are driven by the same universalizing logics and entrenched interests that lay behind damaging projects of the past.

Questioning Integrated and Comprehensive Planning

Advocates of contemporary water planning approaches frequently frame their efforts as a new paradigm, more integrated, flexible, and comprehensive than the heavy-handed and simplistic approaches of the past. Design tools and methods, along with various modeling and 'decision support' tools, technique for 'multi-factor analysis' are part of this drive for synthesis and comprehensive planning and decision-making. The prominent role of design and spatial planning was part of what was to make the Bangladesh Delta Plan 2100 a "holistic and integrated," "broad scope and long-term" adaptive planning and management project (Consultant Team BanDuDeltAS 2014). Similarly, participants in the Changing Course competition and other recent water planning efforts in and around New Orleans have praised the cross-disciplinary synthesis enabled by 'design thinking' and visualization as more integrative and holistic than previous generations of flood mitigation.

This drive for integration and comprehensive analysis and planning is, on its face, a noble and understandable goal, particularly in the context of flood mitigation, an endeavor that has been marked by problems with simplistic assumptions and unintended consequences. However, much as mid-20th century efforts at comprehensive urban planning were widely deemed to be misguided and damaging by critics who questioned the fundamental premises of a unified and knowable "public good" (e.g., Davidoff 1965; Jacobs 1961; Forester and Krumholz 1990), these contemporary efforts at holism and integration in flood planning and adaptation should also be questioned.

Previous generations of flood project planners, no less than today's, saw their projects as comprehensive, interdisciplinary, and adaptive. In Bangladesh, the 1959 Krug Commission report is frequently presented as prototypical of wrong-headed approach of 20th century heavy-handed infrastructural modernization. Yet even in this effort, the authors repeatedly embraced a comprehensive and integrated view. For instance, they argued that,

> the waters of East Pakistan, the rivers, the tidal estuaries and the ground-water constitute an integrated natural system, which is one of the greatest in the world. This calls for complex technical and administrative arrangements, and this task must be approached on an integrated basis and on a scale commensurate with the size of the problem. Flood control, irrigation and drainage, channel maintenance for inland water transport, and power generation and use, all affect each other and are affected by each other. (United Nations Water Control Mission 1959)

The subsequent 1964 IECO Master Plan for water and power development in East Pakistan, which is frequently blamed for initiating generations of damaging interventionist water engineering projects, also regularly invokes the rhetoric of comprehensiveness. Though frequently caricatured as hubristic and rigid, the drafters of the IECO plan, like contemporary planners of the BDP 2100, insisted it should be seen as a work in progress and should be adapted as needed, saying that the plan "should be reviewed regularly and revised as dictated by experience, but only after considering the plan as a whole" (EPWAPDA and IECO 1964).

It is clear that the aspiration to comprehensiveness and adaptability in water infrastructure planning is not new. The unjust and unwise consequences of the much maligned 20th century infrastructural modernization efforts cannot be blamed on a lack of appreciation for the need for holism and flexibility. Given this long-term pattern, it is worth asking: is the contemporary pursuit of comprehensive, integral, and cross-disciplinary planning meaningfully different than the aspirations of these previous efforts? Or, is the aspiration to holism and comprehensiveness actually part of an ongoing pattern of professional hubris, which itself produces the unwise and unjust outcomes of major water planning efforts?

The tendency for recent 'comprehensive,' 'integrative,' and 'holistic' planning processes in Dhaka and New Orleans to endorse potentially damaging mega-projects suggests that there is reason to interrogate the aspiration to comprehensiveness. While the scale and complexity of urban climate adaptation is renewing ambitions for big and integrative projects, it may be that the compounded uncertainties of urbanization and climate change require a mode of planning that is less, rather than more comprehensiveness. Seeing contemporary adaptation projects in the context of historical attempts at integrated and holistic planning suggests that the inherent complexity and pluralism of linked urban socio-ecological systems will inevitably frustrate attempts at comprehensive understanding, planning, and intervention.

Mitigate Fast, Adapt Deliberately... Starting Now

While climate change mitigation requires urgent action, the acute threats of climate change should not be used to depoliticize urban restructuring that can have serious uneven and unpredictable outcomes. As long as infrastructure planning and development are dominated by the same persistent abstract epistemologies and entrenched material interests, crisis-driven adaptation planning will likely yield only superficially rebranded mega-projects that are likely to reproduce the same patterns of unjust and unwise outcomes as past generations. To avoid this fate, adaptation planning must aim to reveal and incorporate alternative ways of knowing and representing urban landscape dynamics and it must incorporate a wider array of material and non-material interests into deliberation and decision-making. Under the compounded uncertainties of climate change and urbanization, creating more equitable adaptation processes will mean developing planning mechanisms that are distributed, iterative, and pluralistic. Miraftab's conceptualization of "insurgent planning" suggests one theorization for such a pluralistic and equity-focused planning (Miraftab 2009).

Existing regimes of planning, spatial governance, and infrastructure finance do not readily lend themselves to this pluralistic and deliberative vision. They are biased in favor of large, consolidated, spatially and temporally discrete projects that can be quantitatively modeled and efficiently financed. Because of the obduracy of existing infrastructures and urban settlement patterns and the need to ensure equitable adaptation in a range of existing urban settings, there will be some cases where large state-led infrastructure projects are necessary and appropriate. However, whether adaptation takes the form of monolithic centralized projects or distributed and pluralistic actions, these processes will create changes in the form, experience, and use of urban space. As such, they are almost certain to incite some

degree of conflict and contestation. Rather than being ignored, obscured, or rushed past in the name of urgency, these contestations must be anticipated and recognized as a necessary and productive means of democratic deliberation.

The Design-Politics of Adaptation

The "design-politics" lens employed in this study revealed new insights about how design representations and realized design projects express social attitudes, meaning, and power relations related to flood mitigation planning and infrastructure. This spatial, visual, and material design-politics often expresses different values and priorities than those expressed in official spoken or written words. Built objects as well as design representations such as maps, renderings, photographs, and logos all served as valuable visual data, reflecting the changing spatial politics of urban flood mitigation in Dhaka and New Orleans. A few of the examples discussed in earlier chapters included:

- Aerial photographs and hydrological diagrams for the rivers of the eastern Bengal delta marked a major shift towards a distant, abstract, and quantified vision of the delta in the mid-20th century Krug Commission report and IECO master plan (see Chapter 3).
- The logos of the central hydrocracies in Bangladesh and the USA, the BWDB and the USACE respectively, both continue to embrace the infrastructural modernization and fortification focus of the mid-20th century (see Chapter 5).
- The Orleans Levee Board's mid-20th century avatar as a protective giant with heavy equipment and sandbags to protect a prosperous, yet vulnerable white family expressed the Board's self-conception and public image at a time when they had been heavily criticized for losing sight of that core protective mission (see Chapter 2).
- Evolving proposal maps which first included and then excluded Kamrangichar from Dhaka's western embankment illustrate the marginalization of this low income area of the city, even as the proposal documents in which the maps were embedded fail to mention the area (see Chapter 4).
- Walls constructed to enclose land in eastern Dhaka are built without bottoms to allow pumped sand to flow under and beyond the land claimed by owners, ruining farming and fishing livelihoods on adjacent parcels, illustrating one of the strategies used to displace peri-urban settlements to make way for landfilled urbanization (see Chapter 4).
- Collaged renderings for the Changing Course competition show new infrastructural landscapes supporting seemingly incompatible uses (e.g., new freight lines and flood barriers alongside duck hunters and oystermen) to suggest that there will be no losers from these major interventions (see Chapter 6).
- Changing Course designers use the visual metaphor of faucet taps to describe the functioning of new sediment diversion structures, betraying the further extension of "big engineering" control in the delta landscape, even as the texts embrace the rhetoric of "designing with nature" and "living with water" (see Chapter 5).
- Another Changing Course finalist's proposal quotes the mid-20th century graphic style of radically simplified delta flow diagrams to illustrate their new proposal, revealing the continuity between contemporary projects and earlier generations of infrastructural modernization, in spite of all of the suggestions of a "new paradigm" of water management (see Chapters 3 and 6).
- Renderings of "improved khals" in the BDP 2100 primarily consist of "improvement" by displacement of small canal-side shacks, betraying a lack of consideration for the urbanization dynamics that generate informal settlements and the uneven costs of their displacement (see Chapter 6).

- The Hatirjheel's flashy features (including musical lighted fountains, sculptural bridges, and waterfront amphitheaters) embody an urbanism that links urban spectacle to stormwater infrastructure, while persistence of the BGMEA building in the middle of the project betrays the radically uneven costs and benefits of such mega-projects (see Chapter 5).

There is a need for further research on the role of design-politics in shaping a range of issues in planning and urbanization, including urban climate adaptation. More nuanced understanding of the production and functioning of design-politics would be of great use for both research on urban spatial politics and for planning and design practitioners hoping to better understand their own agency and capacity to shape urban politics.

Given their capacity for synthesis and persuasive communication, the design and spatial planning disciplines can contribute meaningfully to contemporary urban flood mitigation and adaptation efforts. Recent projects in Dhaka and New Orleans have brought some improvements, widening the scope of disciplinary knowledge brought to bear on urban flood mitigation and demonstrating the value of design and spatial planning tools. However, the recent cases also show that design tools and methods can be potent tools for depoliticizing adaptation and constraining necessary debate and deliberation. If deployed within processes dominated by the same persistent epistemological and material interest biases that have long dominated urban flood infrastructure planning, design and planning tools can become powerful new rhetorical tools for justifying and rebranding damaging mega-projects in the name of climate adaptation.

If designers and planners are to contribute to making climate adaptation an opportunity for broader "transformation" (Pelling 2010), they will need to develop new theoretical and methodological tools. A transformative approach to adaptation design and planning embraces the role of designers as "connectors," bridging not only between different modes of professional knowledge, but also between the universalizing realm of climate adaptation expertise and the context-specific and path-dependent processes of urbanization. This context-specific bridging function requires that designers take seriously the embedded experiential knowledge of people in particular places, at a minimum inquiring into the experience and insights of people who are the most vulnerable to climate impacts and the impacts of planning and infrastructure interventions. While humble inquiry into the embedded knowledge of impacted communities is a good staring point, building sustained collaborative partnerships should be the ultimate goal. Had the planners and designers of Dhaka's western embankment sought out grounded knowledge through ethnographic research and historical inquiry into the emergent impacts of past projects, they would not have built an embankment without anticipating that it would become a driver of urbanization. Had they anticipated that these structures would become spines of urbanization, the project could have been designed and coordinated with other efforts to ensure that induced development had the broadest possible benefits and minimized social and ecological harms. With the contemporary trend towards increasing internationalization of design and adaptation expertise, developing and sustaining such hyper-local engagement, is both more challenging to conduct and more essential than ever.

To contribute to complex pluralistic adaptation processes and to reduce the tendency to be coopted by empowered interests, designers need to develop a more sophisticated understanding of their political position and potential. They need to develop tools for expanding the 'sloppy thinking' of design into the 'messy' realm of urban spatial politics. Rather than shrinking away from points of historical distrust and contestation, designers could help to develop and communicate alternative visions for adaptation that embody the values and priorities of frequently ignored interests. Rather than embracing depoliticized visions of geophysical landscape suitability or promising restoration of idealized pre-modern modes of

settlement, designers could help articulate the uneven impacts of past practices and develop counter strategies for the future. By embracing what Holston calls the "ethnographic present," (Holston 1998) rather than retreating to an idealized past or charging ahead into a naïve alternative future, designers can contribute to rather than constrain the necessary deliberations for pluralistic adaptation.

Possibilities

Many of the findings and recommendations of this study focus on the failures and negative implications of past and present state-led flood mitigation. I have focused on how 20th century flood infrastructural modernization created unjust and unwise outcomes and how contemporary adaptation efforts may be enrolling designers in reproducing these same patterns. However, as I have recognized elsewhere, these same efforts at reviving state-led flood mitigation hold tremendous potential to improve upon past efforts and to advance more equitable adaptation. I will close here with a brief mention of some promising recent and ongoing efforts in Dhaka and New Orleans.

In Dhaka, designers have begun to use the tools of their disciplines to advocate for better and more equitable approaches to urban flood mitigation. The Bengal Institute (BI) for Architecture, Landscapes, and Settlements, a new philanthropically-supported design education and research institute has developed proposals for design interventions to improve the experience and function of the city, including water focused plans for the Buriganga River. The BI's director told me that the group's focus on water and flooding was part of a "shift [that] was triggered by what we saw in New Orleans with Katrina" (Ashraf 2017a). The BI shares their research and design projects widely in the public realm through highly illustrated newspaper stories, well-attended exhibitions, and free festivals (Figure 7.1). The director told me that they adopt this very public approach to design communication to "build desire" among the city's residents on the theory that "that desire can become a demand and maybe that can create change" (Ashraf 2017a). Operating in a mode reminiscent of Patrick Geddes' public planning exhibitions in India in the early 20th century, the BI's public outreach efforts aim to shape public debate in an environment in which planning and political decision making is characterized by deep distrust.

Figure 7.1. A Bengal Institute public exhibition on the future of the Buriganga River in Dhaka.

In his very public advocacy for 'water urbanism,' Iqbal Habib, another Dhaka architect follows a similar approach, appearing on nationally broadcast TV shows on a regular basis. Habib combines his design advocacy work with political mobilization around a host of environmental issues as the leader of one of Bangladesh's most prominent environmental NGO's, Bangladesh Poribesh Andolon (BAPA) or Bangladesh Environment Movement. Like the BI's efforts, Habib presents the tools of design visualization as central to a larger political project. In the context of Dhaka, where spatial governance regimes do not constrain "powerful people" from grabbing land for their private benefit, Habib speaks of the need to "regain the belief of the people." For Habib, design visualization is central to this project. He says that "as [he] is an architect, [he] shows some sketches of how things could be different" to "show the people what is happening" and "make people angry" (Habib 2017).

Neither Habib nor the Bengal Institute substantially focus on the distributional and equity issues surrounding Dhaka's flood vulnerability and adaptation. In both instances, their design proposals are firmly rooted in a blending of global best practices for urban design-integrated and public space oriented water infrastructures. They draw from the Bengal delta's pre-urban settlement patterns, but do not focus particular attention on the "ethnographic present" of Dhaka's overlooked and marginalized peoples. Nonetheless, in their populist methods of using design as a means of communication and popular mobilization, these proposals demonstrate a means of using the political potency of design in a context where democratic and spatial governance institutions are weak and infrastructure planning and development are seriously constrained. These politically-engaged forms of design advocacy could be even more potent if informed by a wider range of perspectives and a more direct consideration of the equity implications of urban restructuring.

In New Orleans and surrounding communities, several recent and ongoing efforts engage the tools of design in flood mitigation infrastructure and planning in novel ways beyond the major Dutch-influenced efforts discussed elsewhere in this study. Two post-Hurricane Katrina university led efforts, the LSU Coastal Sustainability Studio (CSS) and the Small Center for Collaborative Design (formerly the City Center) at the Tulane School of Architecture, mobilize faculty and students in using design and planning tools for projects with a range of community partners. While neither LSU nor Tulane has a planning program, each of these centers have undertaken projects that use design tools to work on issues at the center of this study. In addition to being a local partner for one of the Changing Course competition final teams, the CSS has undertaken several community planning exercises with vulnerable coastal communities, including through a Kresge Foundation-supported Coastal Community Resilience Program. While the CSS has brought some much-needed planning assistance to coastal communities that have been otherwise largely neglected, CSS staff complained that the state's Coastal Protection and Restoration Authority (CRPA) is still dominated by "the old engineering mentality" and, when they have worked together the state agency has "treated [the CSS] as if we were just there to make pictures." These limited expectations, combined with a degree of extra political sensitivity rooted in the CSS's position within a state university in a politically conservative state, have limited their capacity to engage directly in politically contentious issues of climate adaptation.

While most of the Small Center's work has been focused on individual site and building scale projects, the Center has recently addressed more overtly political issues. In 2016 and 2017, the Center mounted exhibitions that explicitly grappled with New Orleans' history of political contestation and dissent related to flood vulnerability and other issues. "Locating New Orleans: An Exploration on Shaky Ground" in 2016 used critical mapping to highlight the city's history of social and environmental precarity, including "a history of choices that work to constrain future choices while often placing undue burdens on the most vulnerable" (Figure 7.2) ("Locating New Orleans: An Exploration on Shaky Ground" 2017). In 2017, the Center mounted another exhibition called "Sites of Resistance," which again used mapping and other forms of visualization to highlight New Orleans' "lineages and spaces of dissent and marginalized stories of inter-racial collaboration" ("Sites of Resistance" 2017). Like the BI's public exhibitions in Dhaka, these Small Center projects use the visual communication tools of design as tools for political discussion and advocacy. In this case, the Small Center explicitly stated its goal as "reconnecting our audience with the possibilities for making change."

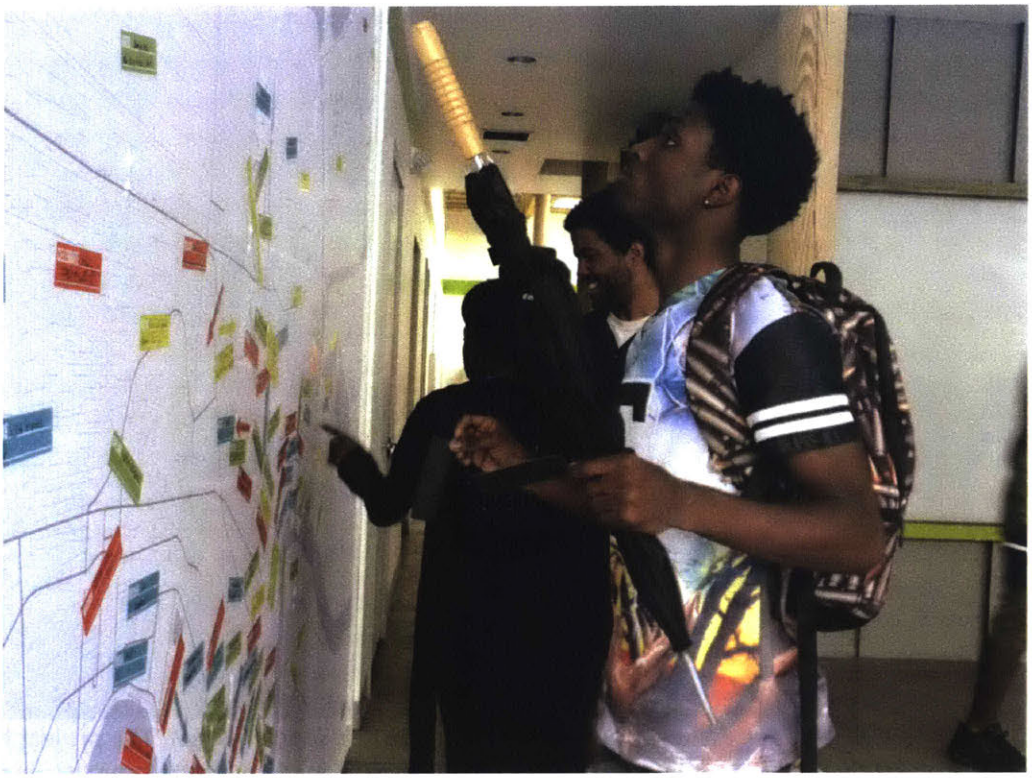

Figure 7.2. A participatory mapping exercise included in the Tulane Small Center's exhibition "Locating New Orleans: An Exploration on Shaky Ground" ("Locating New Orleans: An Exploration on Shaky Ground" 2017).

In addition to these university-led programs, there are also some prominent and promising state-led projects in New Orleans and the wider region that are worthy of note. Three notable ongoing efforts were funded by the Rockefeller Foundation and the federal government through HUD's National Disaster Resilience Competition (NDRC). In the Gentilly Resilience District, the City of New Orleans is implementing several green infrastructure interventions proposed in the *Greater New Orleans Urban Water Plan.* The project includes a large public park, Mirabeau Water Gardens, designed to retain stormwater and a series of "green and blue streets," (Figure 7.3) in which water retention and infiltration landscapes are to be installed as part of the streets and "neutral grounds" or median strips. In addition to opportunistically inserting green infrastructures into an existing neighborhood fabric, a city leader was adamant that this project went beyond the Dutch examples to foreground equity, saying

> Honestly, this is something that the Dutch can learn from us: considering the social and economic components of resilience. This is what they can learn from us. I have always said, I don't care if you build the biggest [flood] walls in the world; if the people inside those walls are living in poverty, what is the point. (Hebert 2017)

The project has focused on equity in both its choice of sites – Gentilly is a largely working-class African-American neighborhood that was devastated in Hurricane Katrina – and in incorporating an ambitious green infrastructure jobs training program. At the time of the fieldwork, it was too early to judge the successes and challenges of the project, but its explicit focus on equity was a positive sign.

Figure 7.3. Rendering of a "green / blue street" for the Gentilly Resilience District. The project has an explicit focus on social and environmental equity, including local hiring and job training (Waggonner and Ball Architects).

The two other NDRC projects in South Louisiana also treat socio-economic equity as central the larger question of the region's climate vulnerability and adaptation. The Native American community on Isle de Jean Charles received a grant to facilitate their collective relocation off of their island on the rapidly eroding coast. Among the central partners in this effort is the Lowlander Center, an advocacy organization that is explicitly focused on ensuring that "Traditional Ecological and Historied Knowledges" are incorporated into south Louisiana's adaptation to climate change ("Mission" n.d.). Finally, funds from the NDRC are also supporting the LA SAFE (Louisiana's Strategic Adaptation to Future Environments) planning process in six parishes surrounding New Orleans that were particularly impacted by Hurricane Isaac in 2012. More than many of the previous Dutch-influenced flood mitigation and adaptation projects in the area, this effort places robust public deliberation at its core (Figure 7.4). The planning process has been led by Concordia, a New Orleans-based planning and design firm. Waggonner and Ball, the architecture firm that has led many of New Orleans' recent water-focused planning efforts is again a central player in the LA SAFE program. Importantly, in this case, the development of design proposals was conceptualized as following from and building upon, rather than leading, the public consultation and deliberation process. The process included funding for demonstration projects to be designed and built in each of the six parishes following a 9-month public engagement and outreach process with residents, government officials, and others. While one area designer complained that LA SAFE is "really all just public process," others saw the effort as a pragmatic effort to realign the region's water planning efforts with the experience and priorities of local people. In this case, design tools were used for mapping and process visualization during the public engagement phases of the work and transitioned into developing project proposals only later. The "catalytic projects" in each parish were envisioned as a means of demonstrating essential elements of the larger strategy developed from the public engagement processes.

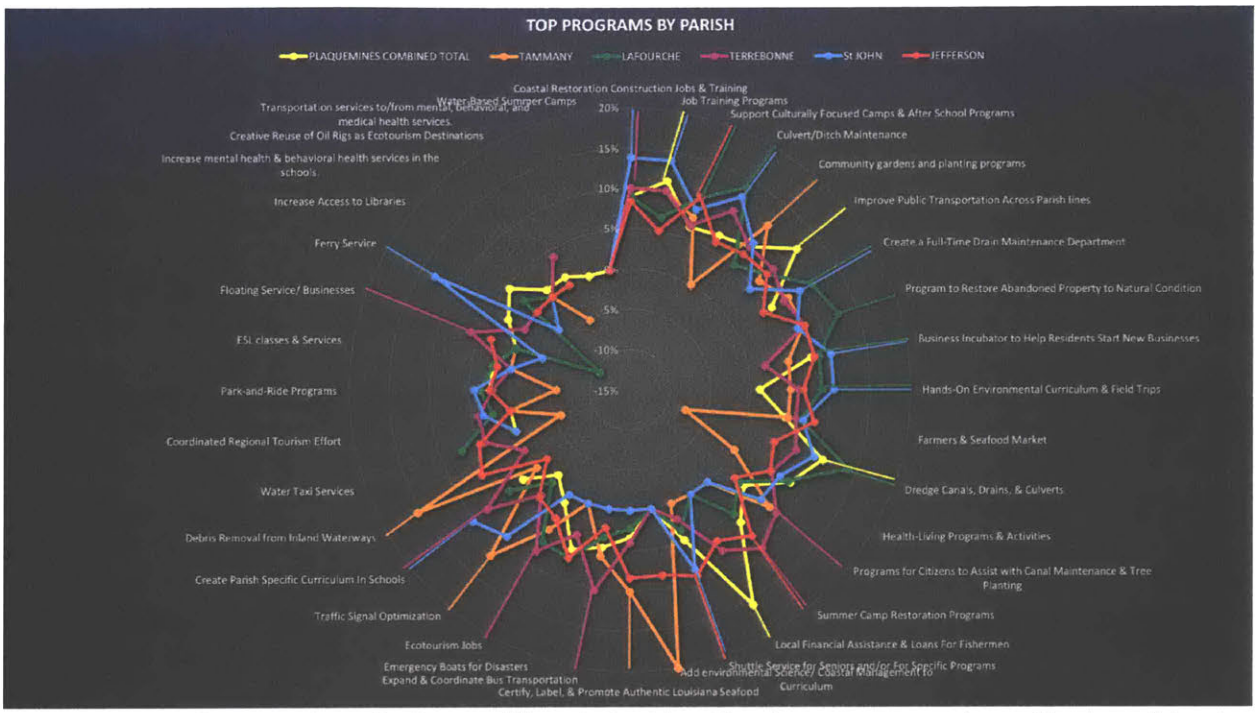

Figure 7.4. Visualization of results from public priority identification process conducted in six parishes by as part of the LA SAFE program. Designers were involved in mapping and visualization during the public process. Based on the outcomes of this extensive process, each parish will work with designers to develop "catalytic" projects (Concordia 2017).

Each of these efforts is necessarily only a localized and partial model. On their own each is inadequate to the challenges of addressing the mounting flood vulnerability in the wider Dhaka and New Orleans areas. In some cases, the projects are preliminary or incomplete. In other cases, they embody both promising and problematic uses of the tools of design and planning. Nonetheless, if a pluralistic model of transformative adaptation is to emerge in Dhaka or New Orleans, these efforts may act as models and inspiration.

The recent resurgence in ambitious state-led flood mitigation in many cities, including Dhaka and New Orleans, reflects an emerging consensus that climate adaptation will require new forms of technical analysis, modeling, and design. These efforts recognize that the scale, complexity, and uncertainty of the effects of climate change on urban environments requires new methods for gathering, analyzing, and representing data and new methods for assimilating that data to design adaptation measures. Recent flood mitigation planning projects have shown that designers can play a productive synthesizing and communicative role in the technical process of generating innovative adaptation solutions. However, the cases of Dhaka and New Orleans also make clear that technical innovation is not enough. Adapting cities to climate change linked flood hazards will inevitably generate unevenly distributed costs and benefits. Protective infrastructures will protect some areas and leave others exposed. New landscape based green infrastructures will shift how people live, build, and earn their livelihoods. Navigating the conflict and contestation that will come with these changes and ensuring that the most vulnerable residents of cities do not bear a disproportionate burden will require new forms of democratic deliberation and pluralistic planning. The nascent possibilities demonstrated in the examples highlighted above provide hope that designers can be part of enabling pluralistic, equity-centered deliberation about the future of cities.

APPENDIX 1
LIST OF EXPERT INTERVIEWS

NEW ORLEANS

Civil Society

Cochran, Steve. Environmental Defense Fund, New Orleans, LA, August 30, 2017.

Marshall, Bob, Environmental Journalist, The Lens, New Orleans, January 18, 2017.

Moore, Amanda, National Wildlife Federation, Louisiana Coastal Campaign, New Orleans, LA, January 15, 2014.

Peterson, Kristina. Lowlander Institute, New Orleans, LA. January 23, 2014.

Peyronnen, Natalie. Environmental Defense Fund, August 1, 2017 (by phone).

Rosenthal, Sandy. Director, Levees.org, New Orleans, LA, January 19, 2017.

Viles, Aaron. Gulf Restoration Network, New Orleans, LA, January 15, 2014.

Academic

Birch, Traci. Coastal Sustainability Studio, LSU, Baton Rouge, LA, July 28, 2017.

Carney, Jeff. Director, Coastal Sustainability Studio, LSU, Baton Rouge, LA, July 28, 2017.

Laska, Shirley. Director (retired), UNO Center for Hazards Assessment, Response and Technology, New Orleans, LA, January 18, 2017.
New Orleans, LA, January 23, 2014.

Lewis, Josh. Researcher, Tulane University ByWater Institute, New Orleans, LA, January 18, 2017.

Maygarden, Dinah. University of New Orleans, New Orleans, LA, January 24, 2014.

Willson, Clint. LSU, Water Campus, Baton Rouge, LA. July 28, 2017.

Yoachim, Ann. Tulane University. New Orleans, LA, January 13, 2014.

Designers, Planners, and Consultants

Agre, Claire. West 8 Landscape Architecture, New York City, NY. June 15, 2017.

Brown, Dana. Brown Danos and Associates Landscape Architecture, New Orleans, LA. August 30, 2017

Chang, Aron. Waggonner and Ball Architects, Ripple Effect, New Orleans, LA. January 19, 2017.

De Saalm, Jaap. HNS Landscape Architects, Amersfoort, The Netherlands, May 9, 2017.

De Konning, Robbert. Landscape Architect. Arnhem, The Netherlands, May 4, 2017.

Hill, Bobbie. Concordia, New Orleans, LA, August 31, 2107.

Koole, Stijn. Landscape architect, Bosch Slabbers, The Hague, The Netherlands, July 22, 2016.

Minns, Tony. Deltares. Delft, The Netherlands, May 1, 2017.

Sloff, Kees. Deltares, Delft, The Netherlands, May 8, 2017.

Smith, Thom. Waggonner and Ball Architects, August 29, 2017.

Stuurman, Roelof. Deltares. Amsterdam, The Netherlands, July 26, 2016.

Thomaes, Sabien. Palmbout, Rotterdam, The Netherlands. April 26, 2017.

Van de Ven, Frans. Deltares, Utrecht, The Netherlands, May 5, 2017.

Government Officials

Hebert, Jeff. Chief Resilience Officer, Deputy Mayor for Administration, City of New Orleans, New Orleans, LA, August 1, 2017.

Holder, Ken. Public Affairs Officer, New Orleans District, US Army Corps of Engineers, New Orleans, LA, January 14, 2014.

Inman, Brad. US Army Corps of Engineers, New Orleans, LA, July 26, 2017.

McHugh, Colleen. Office of Sustainability and Resilience, City of New Orleans, New Orleans, LA, January 20, 2017.

DHAKA

Civil Society

Huq, Saleem. IIED, International Center for Climate Change and Development, Dhaka, Bangladesh, February 17, 2017.

Islam, Nazrul. United Nations. New York, NY. June 16, 2017.

Alam, Sarder Shafiqul. International Center for Climate Change and Development, Dhaka, Bangladesh, July 15, 2014.

International Aid / Lending Institutions

Kazi, Swarna. Global Facility for Disaster Risk Reduction (GFDRR), World Bank, Dhaka, Bangladesh, March 9, 2017.

Dhaka, Bangladesh, August 21, 2015.

Meyer, Patrick. USAID, Dhaka, Bangladesh, February 22, 2017.

Rubinyi, Steven. World Bank, Dhaka, Bangladesh, March 30, 2017.

Shakil, Shahadat. USAID, Dhaka, Bangladesh, February 22, 2017.

Academic

Ahmed, Sharif Uddin. Professor of History, North South University, Dhaka, Bangladesh, February 25, 2017.

Ahmed, Shabbir. Head of Department, Bangladesh University of Engineering and Technology, Dhaka, Bangladesh, April 5, 2017.

Ahmed, Tanvir. Professor of Civil and Environmental Engineering, Bangladesh University of Engineering and Technology, Dhaka, Bangladesh, July 5, 2014.

Iqbal, Iftekar, Professor of Environmental History, Dhaka University, Dhaka, Bangladesh, July 2014.

Islam, Sirajul, Professor of Civil and Environmental Engineering, North South University, Dhaka, Bangladesh, April 5, 2017.

Khan, Shah Alam. Institute of Water and Flood Management, Bangladesh University of Engineering and Technology, Dhaka, Bangladesh, April 2, 2017.

Nishant, Ainun. Professor, BRAC University, Dhaka, Bangladesh, March 8, 2017.

Rahman, Mujibur. Professor of Civil and Environmental Engineering, Bangladesh University of Engineering and Technology, Dhaka, Bangladesh, April 2, 2017.

Rogers, Peter. Professor of Geology, Harvard University (retired), Cambridge, MA, May 25, 2016.

Salehin, Mashfiqus. Institute of Water and Flood Management, Bangladesh University of Engineering and Technology, Dhaka, Bangladesh, March 16, 2017.

Government Agencies

Municipal

Alam, Saiful. Director Technical, Water and Resources Planning Organization (WARPO), Dhaka, Bangladesh, March 16, 2017.

Azad, Abul Kalam. Planning Director, Chief Engineer, Central Division (retired), Bangladesh Water Development Board, Dhaka, Bangladesh, April 6, 2017.

Chaudhury, Akhter Hossain. Urban Planner, Sheltech and RAJUK, Dhaka, Bangladesh, February 27, 2017.

Hafiz, Gholam. RAJUK, Dhaka, Bangladesh, March 19, 2017.

Hossain, Akhter. RAJUK, Dhaka, Bangladesh, March 16, 2017.

Hossain, Sazzan. Flood Forecasting and Modeling, Bangladesh Water Development Board, March 12, 2017.

Islam, Sahidul. Project Engineer, Eastern Dhaka Embankment, Bangladesh Water Development Board. Dhaka, Bangladesh, March 12, 2017.

Islam, Sirajul, Chief Planner, Dhaka South City Corporation, Dhaka, Bangladesh, July 13, 2014.

Islam, Sirajul. Chief Planner, RAJUK, Dhaka, Bangladesh, July 13, 2014.

Islam, Tamidul. Planning Directorate, Bangladesh Water Development Board, March 12, 2017.

Kabir, Hasibul. RAJUK, Dhaka, Bangladesh, April 6, 2017.

Kashem. Dhaka Water and Sewer Authority, Dhaka, Bangladesh, March 29, 2017.

Latif Mia, Mohammad Ahmad. Bangladesh Water Development Board, Dhaka, Bangladesh, July 14, 2014.

Qaium, Mohammad Aminul, RAJUK, Dhaka, Bangladesh, March 15, 2017.
February 26, 2017.
February 20, 2017.
July 13, 2014.

Rahman, Taibur. UNDP (Formerly General Economic Division, Planning Commission), Dhaka, Bangladesh, February 20, 2017.

Rahman, Mizanur. Project Director, Bangladesh Delta Plan 2100 Formulation Project, Bangladesh Water Development Board, March 12, 2017.

Rifat, Bangladesh Water Development Board, Dhaka, Bangladesh, March 30, 2017.

Zaman, Mukles. Director General (retired), Bangladesh Water Development Board, Dhaka, Bangladesh, March 15, 2017.

Designers, Planners, and Consultants

Ahmed, Farhana. Consultant, CEGIS, Dhaka, Bangladesh, March 21, 2017.

Al Shafi, Jami, Architect, Dhaka, Bangladesh, March 9, 2017.

Ashraf, Kazi. Director, Bengal Institute, Dhaka, Bangladesh, February 26, 2017.
Dhaka, Bangladesh, April 4, 2017.
Dhaka, Bangladesh, July 5, 2014.

Chaudhury, Giasuddin. Mott MacDonald (formerly of Bangladesh Water Development Board), March 30, 2017.

Dahm, Ruben. Deltares. Delft, the Netherlands, May 1, 2017.

de Kort, Robert. Defacto Urban and Landscape Design, Rotterdam, The Netherlands, July 22, 2016.

Arcadis, Amsterdam, The Netherlands, May 1, 2017.

Habib, Iqbal. Architect, Vitti, Dhaka, Bangladesh, March 12, 2017.

Hasan, Shahnoor. Doctoral Student, UNESCO IHE, Dhaka, Bangladesh, March 21, 2017.

Haque, Saiful. Sthapati, Architect, Dhaka, Bangladesh, February 26, 2017.

Hossain, Ansar. Urban Planner, Dhaka, Bangladesh, March 14, 2017.
Dhaka, Bangladesh, July 26, 2014.

Khan, Abu Saleh. Deputy Director, Institute of Water Modeling, Dhaka, Bangladesh, March 19, 2017.

Khan, Malik Fida. Deputy Executive Director, Center for Environmental and Geographic Information Systems (CEGIS), Dhaka, Bangladesh, March 21, 2017.

Khan, Zahirul Haque. Institute of Water Modeling, Dhaka, Bangladesh, March 21, 2017.

Loes Nilleson, Anne. Defacto, Rotterdam, The Netherlands. April 26, 2017.

Oberhagemann, Knut. Consultant, NHC, Dhaka, Bangladesh, March 27, 2017.

Oliemans, William, Deltares, Dhaka, Bangladesh, March 7, 2017.

Rahman, Neaz Khondaker. Consultant, Institute of Water Modeling, Dhaka, Bangladesh, March 28, 2017.

Rahman, Mahbubur. Director of Water Resources Planning Division, Institute of Water Modeling, Dhaka, Bangladesh, March 19, 2017.

Rammelt, Crelis. Dhaka, Bangladesh, July 25, 2014.

Rashid, Maruf. Urban Planner, Bashundhara Group, Dhaka, Bangladesh, March 29, 2017.

van den Berg, Hanne. Deltares (by phone), August, 26, 2015.

van der Valk, Bert. Deltares, Delft, The Netherlands, July 25, 2016.

van Scheltinga, Catharine Terwisscha. Wageningen, Dhaka, Bangladesh, February 27, 2017.

APPENDIX 2
ARCHIVES CONSULTED

New Orleans Material
Louisiana State Archive, Baton Rouge, Louisiana

Louisiana Research Collection, Tulane University, New Orleans

New Orleans City Archives, New Orleans Public Library, New Orleans

Louisiana Collection, University of New Orleans, New Orleans

Dhaka Material
India Office Archives, British Library, London, UK

National Archive of Bangladesh, Dhaka

Bangladesh University of Engineering and Technology, Department of Civil and Environmental Engineering, Dhaka

Newspaper Archive, Dhaka University, Dhaka

West Bengal State Archive, Kolkata, India

National Library, Kolkata, India

Strathclyde University, Patrick Geddes Archives, Glasgow, Scotland

University of Edinburgh Archives, Edinburgh, Scotland

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