THE HYDROGRAPHIC CITY: MAPPING MEXICO CITY'S URBAN FORM IN RELATION TO ITS AQUATIC CONDITION, 1521-1700

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ABSTRACT

Mexico City is a special case in urban history because the measures taken by the Aztec and Spanish to avoid inundations have fundamentally changed the city's character. In 1521, it was an island-city; in 1629, it lay near the banks of Lake Mexico; and by 1700, it rested on a reclaimed mainland. This transformation is significant, speaking not only to the flood control approaches of the Aztec and Spanish, but equally important, to how these methods profoundly altered this city's urban condition. Like the Aztec, the Spanish sought to control the six lakes surrounding the city to prevent inundations, yet their approach was quite different. The Aztec relied on containment and regulation, while the Spanish undertook drainage, referred to as the *desagüe*. Despite the scholarly attention devoted to pre-Columbian and colonial hydraulics, no research examines the relationship between the city's lacustrine environment and its urban transformation. "The Hydrographic City" addresses three key questions: (1) *What were the respective flood control approaches of the Aztec and Spanish?* (2) *How did these approaches shape two different cities?* (3) *How did the Aztec and the Spanish differ in how they conceived the city's aquatic condition, and what were the epistemological roots of their strategies for coming to terms with it?*

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Archives and Repositories

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Introduction

On August 13, 1521, Hernán Cortés, his men, and indigenous allies defeated the Aztec. Within two centuries after being founded in 1325, the Aztec capital, Tenochtitlan, had become the most powerful city in Mesoamerica. At its apex, it consisted of over four hundred tributary settlements throughout thirty-eight provinces. In defeating the "superpower" of the pre-Columbian world and occupying their city, Cortés positioned the Spanish atop a pre-existing framework that had benefited the Aztec.[1] Occupying Tenochtitlan's site thus provided Cortés and subsequent colonial governments the means to become the main beneficiaries of this system.

Cortés' decision to settle the Aztec island capital was an astute political move. However, this choice meant that the Spanish settlement would be continually exposed to flooding.[2] Flooding has plagued Mexico City and its pre-Columbian predecessor Tenochtitlan since at least 1429. By 1700, inundations had devastated these cities on at least 14 occasions, with one of these lasting a surprising five years.[3] The effort to control the island's susceptibility to flooding extends from the pre-conquest into the colonial periods of this nearly seven-hundred-year-old city. The cause of inundations is simple: Tenochtitlan, later Mexico City, was founded on an island located at the lowest point of the Basin of Mexico where water naturally settles, and despite its elevation of 2,240 meters above sea level, it has no natural outlet.[4] Although floods have repeatedly overwhelmed this site for more than half a millennium, no permanent remedy

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[1] Johanna Broda, Davíd Carrasco, and Eduardo Matos Moctezuma, *The Great Temple of Tenochtitlan: Center and Periphery in the Aztec World* (Berkeley: University of California Press, 1988), 126.
[2] Charles Gibson, *The Aztecs Under Spanish Rule: A History of the Indians of the Valley of Mexico, 1519-1810* (Stanford: Stanford University Press, 1999), 368.
[3] Prior to 1700, the Tenochtitlan, and later Mexico City, was flooded in 1429, 1449, 1499, 1552, 1553, 1555, 1579-1580, 1604, 1607, 1623, 1629-1634, 1647, 1691, and 1697.
[4] Exequiel Ezcurra, *De las Chinampas a la Megalópolis: el medio ambiente en la Cuenca de México*, 3rd ed. (Mexico City: Secretaría de Educación Pública / Fondo de Cultural Económica / Consejo Nacional de Ciencia y Tecnología, 2003), 11-12.

has been achieved. As we shall see, the solutions proposed to end this centuries-old problem have varied.

The island site is a special case in urban history. The measures taken by the Aztec and Spanish to avoid inundations have fundamentally changed its character. In 1325, it was an uninhabited island; in 1521, it was an island-city at least five times its original size; and by 1700, it rested on a reclaimed mainland. This transformation is significant, speaking not only to the flood control approaches of the Aztec and Spanish, but equally important, to how these methods profoundly altered each settlement's urban condition. Like the Aztec, the Spanish sought to control the six lakes surrounding the city to prevent inundations, yet their approaches were quite different. The Aztec relied on the containment and regulation of the lakes, while the Spanish undertook drainage, referred to as the *desagüe* (literally, "de-watering").[5] Despite the scholarly attention devoted to pre-Columbian and colonial hydraulics, no research examines the relationship between each city's lacustrine environment and its urban form. "The Hydrographic City" addresses three key questions: (1) *What were the respective flood control approaches of the Aztec and Spanish?* (2) *How did these approaches shape two different cities?* (3) *How did the Aztec and the Spanish differ in how they conceived the city's aquatic condition, and what were the epistemological roots of their strategies for coming to terms with it?*

Historical Images: Past Methods and New Approaches

Hitherto, studies describing pre-Columbian and colonial hydraulics, and studies of the urban forms of these two cities, have been examined within their respective frames—yet,

[5] Richard L. Kagan with the collaboration of Fernando Marías, *Urban Images of the Hispanic World, 1493-1793* (New Haven: Yale University Press, 2000), 153.

surprisingly, never in relation to each other. This dissertation is the first comparative study of the influences of Aztec and Spanish hydraulic practices on their respective settlements' urban form. A significant departure of this research from previous individual urban and water management investigations is its emphasis on the histories of art, cartography, technology, and the environment as a means to a fuller understanding of the nature of the city.

Underpinning this study of hydraulics and urban form is a series of sixteenth- and seventeenth-century maps, drawings, and paintings made by native artists (*tlacuilos*) and Europeans that describe Tenochtitlan's and Mexico City's relationship to its surrounding lacustrine environment. In the history of art and cartography, historical images are prime sources for illuminating the character of both cities. Surprisingly, prior studies of pre-Columbian hydraulics have simply overlooked this body of images. Equally as disconcerting, despite the scholarly attention devoted to the *desagüe*, the images describing drainage have received little attention. General speaking, *desagüe* scholars have treated historical images as mere illustrations. They, like their counterpart scholars of pre-Columbian water management, have failed to interpret the graphic commentary embedded in visual documents. To date, only two studies (one by the present writer) have examined images associated with colonial flood control. Vera Silvina Candiani in "Bourbons and Water" employed cross-sectional drawings in a brief four-page analysis of the *desagüe*.[6] "In the Art of My Profession" examined the maps associated with the Dutch hydraulic engineer Adrian Boot's flood control proposal of the early seventeenth century.[7] Other than these two studies, no published attempt has been undertaken to understand water management via its image. With this lacuna in mind, it is no wonder that we have been limited in

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[6] Vera Silvina Candiani, "Bourbons and Water," in *Mapping Latin America: A Cartographic Reader*, ed. Jordana Dym and Karl Offen, 70-73 (Chicago: University of Chicago Press, 2011).

[7] John F. López, "'In the Art of My Profession': Adrian Boot and Dutch Water Management in Colonial Mexico City," in "Imperial Geographies and Spatial Memories in Spanish America, ed. Alexander Hidalgo and John F. López, special issue, *Journal of Latin American Geography* 11 (2012): 35-60.

understanding how water management was conceived pictorially on the one hand, and what effects it had upon the urban forms of Tenochtitlan, and later, Mexico City, on the other.

Although they have rarely been read as resources for comparative urbanism, maps of Mexico City and Tenochtitlan have been a topic of interest for some time. This concern has taken the form of collecting images of both cities to serve as a resource for scholarly analysis.[8] Prime examples of these kinds of publications are the *Atlas histórico de la ciudad de México*; *500 planos de la ciudad de México, 1325-1993*; *Mapas antiguos del Valle de México*; and *Planos de la ciudad de México*. The lone exception to this rule is *Planos de la Ciudad de México, siglos XVI y XVII: estudio histórico, urbanistico, y bibliográfico* by Manuel Toussaint, Federico Gómez de Orozco, and Justino Fernández.[9] Originally published in 1938 (republished in 1990), these scholars undertook the examination of four images—*Nuremberg Map*, *Uppsala Map*, *Plano en papel maguey*, and *Forma y levantado de la ciudad de México*—within the images' historical, urbanistic, and bibliographic contexts.

Interpreting historical images for graphic commentary on water and urban phenomena is a multi-layered task. Colonial Indians and Europeans made maps and other visual documents describing Tenochtitlan and Mexico City. A comprehensive analysis of these sources has not yet been offered. To understand how both cities were depicted over the span of nearly two centuries requires knowledge of the cartographic traditions of central Mesoamerica, colonial Mexico, and Europe. The history of European cartography and of the genre of city maps and views is well

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[8] Sonia Lombardo de Ruíz with the collaboration of Yolanda Terán Trillo, *Atlas histórico de la Ciudad de México*, 2 vols. (Mexico City: Smurfit Cartón y Papel de México, 1996); Ethel Herrera Moreno, Concepción de Ita Martínez, and Beatrice Trueblood, *500 planos de la ciudad de México, 1325-1993* (Mexico City: Secretaría de Asentamientos Humanos y Obras Públicas, 1982); Ola Apenes, *Mapas antiguos del Valle de México* (Mexico City: Instituto de Historia, Universidad Nacional Autónoma de México, 1947); and Manuel Carrera Stampa, *Planos de la Ciudad de México (desde 1521 hasta nuestros días)* (Mexico City: Sociedad Mexicana de Geografía y Estadísticas, 1949).

[9] Manuel Toussaint, Federico Gómez de Orozco, and Justino Fernández, *Planos de la Ciudad de México, siglos XVI y XVII: estudio histórico, urbanistico, y bibliográfico* (Mexico City: Universidad Nacional Autónoma de México, 1990).

documented. In Latin American, it is a subject less studied for Spanish American cities.[10] Recently, historian Richard L. Kagan has offered a basis by which to understand Spanish American city views in *Urban Images of the Hispanic World, 1493-1780.*[11] Regrettably, for this reader, Indian-made maps accounted for only a small sample of the views studied.

The study of colonial Indian-made maps is not straightforward. They fuse pre-Hispanic mapping practices with European ones, providing a "mixed" appearance. These maps, for a host of reasons, transformed the traditional cartographic methods of central Mesoamerica and Europe, producing a sub-genre of maps within the broader field of the history of cartography.[12] Colonial Indian maps have been examined within the rubrics of hybridity or *Mestizaje,* given their "mixed" look, or alternatively parsed as indices of indigenous agency.[13]

With respect to the latter, colonial-indigenous maps have primarily been studied as judicial documents. In particular, they were useful when disagreements arose between native communities and Spaniards. For example, art historian Dana Leibsohn has noted that the greatest number of maps authored by indigenous peoples were produced to aid native communities in the Spanish courts over any number of issues, largely (but not limited to) defending their claims to land and natural resources.[14] More recently, historian Alexander Hidalgo examined how the

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[10] For an understanding of chorography in European city views and maps, see Thomas Fangenberg, "Chorographies of Florence: The Use of City Views and City Plans in the Sixteenth Century," *Imago Mundi* 46 (1994): 41-64; David Friedman, "'Fiorenza': Geography and Representation in a Fifteenth-Century City View," *Zeitschrift für Kunstgeschichte* 64, Bd., H. 1 (2001): 56-77; Richard L. Kagan, "Philip II and the Art of the Cityscape," in "The Evidence of the Art: Images and Meaning in History," *Journal of Interdisciplinary History* 17, no. 1 (Summer, 1986): 115-135.

[11] Kagan, *Urban Images of the Hispanic World.*

[12] In addition, it is a field that is still emerging and one that is developing its own methodological approaches for interpreting colonial Indian-made maps.

[13] For an essay that specifically tackles the issue of hybridity in a colonial Latin American art historical context, see Carolyn Dean and Dana Leibsohn, "Hybridity and Its Discontents: Considering Visual Culture in Colonial Spanish America" *Colonial Latin American Review* 12, no. 1 (2003): 5-35

[14] Dana Leibsohn, "Colony and Cartography: Shifting Signs on Indigenous Maps of New Spain," in *Reframing the Renaissance: Visual Culture in Europe and Latin America, 1450-1650*, ed. Claire Farago (New Haven: Yale University Press, 1995), 267-268.

Mixtec community of Santa Cruz Xoxocotlán in Oaxaca produced a series of maps for legal proceedings in "A True and Faithful Copy: Reproducing Indian Maps in the Seventeenth-Century Valley of Oaxaca."[15] In yet another example, art historian Ana Pulido Rull analyzed a series of *merced* maps to explicate native responses to Spanish land distribution policies in her dissertation "Land Grant Painted Maps: Native Artists and the Power of Visual Persuasion in Colonial New Spain."[16] Within this frame, native-made maps have been conceived as legal documents that spoke to contentious relationships between Spaniards and Indians. In this respect, these studies fall in line with the idea of Indian resistance to Spanish hegemony and thus demonstrate a form of agency. These approaches afford understanding of cultural change, acculturation, and interaction between Indians and Spaniards.

However, earlier scholarship on native maps lacked a positive outlook. The concept of *loss* has been used as a methodological lens by which to understand colonial indigenous cartography. Most notably, historian Serge Gruzinski employed the notion of "cartographic loss" when explaining the "disintegration" of a pre-Columbian Indian mapping tradition under the influence of European colonization in "Colonial Indian Maps in Sixteenth-Century Mexico."[17] In response to Gruzinski's view, Kagan noted that the former took a narrow view of European mapping traditions when restricting it only to the kind of "scientific" cartography practiced by Frisius, Mercator, or Ortelius.[18] Importantly, Kagan also presented an argument that scientific mapping practices were just as foreign to Europeans as they were to indigenous peoples. Ricardo

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[15] Alexander Hidalgo, "A True and Faithful Copy: Reproducing Indian Maps in the Seventeenth-Century Valley of Oaxaca," in "Imperial Geographies and Spatial Memories in Spanish America, ed. Alexander Hidalgo and John F. López, special issue, *Journal of Latin American Geography* 11 (2012): 117-144.

[16] Ana Pulido Rull, "Land Grant Painted Maps: Native Artists, Defense of Territory, and the Power of Visual Persuasion in Colonial New Spain" (PhD diss., Harvard University, 2012).

[17] Serge Gruzinski, "Colonial Indian Maps in Sixteenth-Century Mexico: An Essay in Mixed Cartography," *RES: Anthropology and Aesthetics* no. 13 (Spring 1987): 46-61.

[18] Kagan, *Urban Images of the Hispanic World*, 46.

Padrón has also problematized this perceived negative binary between indigenous and European maps. In questioning this binary, Padrón offered a third category of analysis that "recognizes change and diversity in the European side of the [cartographic] equation" in "Mapping Plus Ultra: Cartography, Space, and Hispanic Modernity."[19] Pointedly, Padrón reminds historians of early colonial Latin America that Europe went through its own cartographic revolution during the Renaissance—describing how mathematical abstraction was a learned science, available to a select few and not universally understood. He writes that space in the cartographic sense was an "emergent trend located in a particular sector of culture—technical specialist—rather than a widespread phenomenon involving Europe as a whole."[20]

Thinking similarly to Gruzinski, but within a wider field of indigenous artistic production, stands art historian George Kubler. In "On the Colonial Extinction of the Motifs of Pre-Columbian Art," Kubler reports being asked to write on the "survival of native art motifs" in the colonial period.[21] Instead, he wrote of their extinction. Examples of survival, for Kubler, were "so few and scattered that their assembling requires an enormous expenditure for a minimal yield, like a search for the fragments of a deep-lying shipwreck."[22] Concepts like "cartographic loss," "disintegration," or "extinction" will not aid us in comprehending Indian-made maps. Eventually, we would arrive at similar conclusions as Gruzinski and Kubler.

In 1959, art historian Donald Robertson argued for a theory of *fusion* when studying early colonial indigenous paintings. Noting that Indian paintings were traditionally understood as a "Spanish addition to native traditions or a native acceptance of Spanish influence," he makes the

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[19] Ricardo Padrón, "Mapping Plus Ultra: Cartography, Space, and Hispanic Modernity," *Representations* 79, no. 1 (Summer 2009), 44.
[20] *Ibid.*
[21] George Kubler, "On the Colonial Extinction of the Motifs of Pre-Columbian Art," in *Essays in Pre-Columbian Art and Archaeology*, ed. Samuel K. Lothrop and others, 14-34 (Cambridge: Harvard University Press, 1961):
[22] *Ibid.*, 14.

claim that this was not an instance where influences are "operating upon existing art styles," but rather, where Spanish and native art styles met to "create a new synthesis." More recently, scholars such as Mundy, Leibsohn, and Alessandra Russo, among others, have examined the cartographic production of colonial indigenous mapmakers for how their hybrid strategies order and convey spatial meaning.[23]

To comprehend colonial Indian-made maps within a study of colonial hydraulics, I argue that in addition to a model of hybrid startegies, we can also look to the methodological approaches of critical cartography. A case in point: the mapping historian J. B. Harley offers a perspective by which to understand a wide range of maps. In *The New Nature of Maps: Essays in the History of Cartography*, Harley argues for considering maps as indices of power and knowledge.[24] Maps, for Harley, are multivalent, socially constituted, and inherently political images that do not reproduce a topographic reality, but instead interpret it while employing intellectual processes (artistic or scientific) to create a distinctive type of knowledge. With Harley's cartographic ideas in mind, we can not only scrutinize Indian-made maps, but also European ones, side-by-side, for their graphic commentary. In the case of Tenochtitlan and Mexico City, a comparative study of historical images will reveal how Aztec and Spanish, respectively, conceived of the cities in relation to its aquatic condition.

One last comment on the role of historical images in this dissertation. The *Nuremberg Map* and *La mui noble y leal Ciudad de México*, made in 1524 and ca. 1690, respectively, mark

[23] Barbara E. Mundy, *The Mapping of New Spain: Indigenous Cartography and the Maps of the Relaciones Geográficas* (Chicago: University of Chicago Press, 1996); Dana Leibsohn, "Mapping After the Letter: Graphology and Indigenous Cartography in New Spain," in *The Language Encounter in the Americas, 1492-1800: A Collection of Essays*, ed. Edward G. Gray, Norman Fiering, 119-154 (New York: Berghahn Books, 2000); and Alessandra Russo, *El realismo circular: tierras, espacios, y paisajes de la cartografía novohispana siglos XVI y XVII* (Mexico City: Instituto de Investigaciones Estéticas, Universidad Nacional Autónoma de México, 2005.

[24] J. B. Harley, *The New Nature of Maps: Essays in the History of Cartography*, ed. by Paul Laxton (Baltimore: Johns Hopkins University Press, 2002), 77.

the temporal boundaries of this study, but with one significant exception. The *Nuremberg Map,* with its image of Tenochtitlan, offers the means by which to examine the pre-Columbian period (1325-1521) with respect to the themes of this research. Regrettably, no pre-Hispanic image of the Aztec capital is known.

Pre-Columbian Water Management and Urban Form

The study of pre-Columbian hydraulics has primarily occurred through the examination of large-scale water management practices for agricultural production.[25] It is an area of research linked to the theories put forth by Karl August Wittfogel. In 1957, Wittfogel, a scholar of Chinese economic history, published *Oriental Despotism: A Comparative Study of Total Power.*[26] Wittfogel's premise centered on describing how and why some societies developed complex bureaucracies to manage large-scale hydraulic projects for agricultural irrigation, which for him, created the possibility for despotism.[27] Such societies were termed *hydraulic societies* and their state-produced agriculture was called *hydraulic agriculture.*[28] For Wittfogel, *hydraulic societies* developed not through a technological superiority of their water-controlling devices, but rather through their method of organizing labor, which in his view was "Asiatic," a concept

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[25] Ángel Palerm, *Agricultura y sociedad en Mesoamérica* (Mexico City: Secretaría de Educación Pública, 1972); Ángel Palerm and Eric Wolf, *Agricultura y civilización en Mesoamérica* (Mexico City: Secretaría de Educación Pública, 1972); Ángel Palerm, "La evolución de Mesoamérica y la teoría de la sociedades hidráulicas," in *México prehispánico: ensayos sobre evolución y ecología*, ed. Carmen Palerm Viqueira, 99-118 (Mexico City: Consejo Nacional para la Cultura y Artes / Dirección General de Publicaciones, 1990); Teresa Rojas Rabiela, ed., *La agricultura chinampera* (Chapingo, State of Mexico: Dirección de Difusión Cultural, Universidad Autónoma Chapingo, 1983); and Teresa Rojas Rabiela and William T. Sanders, eds., *Historia de la agricultura: época prehispánica-siglo XVI* (Mexico City: Instituto Nacional de Antropología e Historia, 1985), among others.

[26] Karl August Wittfogel, *Oriental Despotism: A Comparative Study of Total Power* (New Haven: Yale University Press, 1957).

[27] E. R. Leach, "Hydraulic Society in Ceylon," *Past & Present* no. 15 (Apr., 1959), 4-5.

[28] Karl August Wittfogel, "Developmental Aspects of Hydraulic Societies," in *Irrigation Civilizations: A Comparative Study; A Symposium on Method and Results in Cross-Cultural Regularities*, ed. Julian Haynes Steward (Washington D. C.: Social Science Section, Department of Cultural Affairs / Pan American Union, 1955), 44.

based on Karl Marx's "Asiatic mode of production."[29] In comparison, *hydroagricultural societies*, according to this theoretical framework, did not seek to build hydraulic devices such as dams, dikes, and aqueducts to supply water to crops. Rather, they depended on rainfall as their primary means for irrigation and, more importantly, functioned without the "patterns of organization and social control" that necessitated a centralized state.[30] The state, for Wittfogel, was the ultimate expression of *total power*. In his view, it organizes and deploys a large disciplined workforce to implement its irrigation and agricultural policies to obtain surpluses.[31] In 1957, he wrote:

> If irrigation farming depends on the effective handling of a major supply of water, the distinctive quality of water—its tendency to gather in bulk—becomes institutionally decisive. A large quantity of water can be channeled and kept within bounds only by the use of mass labor; and this mass labor must be coordinated, disciplined, and led.[32]

While some embraced Wittfogel's hypothesis of *hydraulic societies* as "a conceptual answer to Marxism and an ideological weapon against modern totalitarian systems, specifically Communism," it was not well received by all.[33] Some criticized Wittfogel as environmentally deterministic. In response, he wrote that "ecological determinism oversimplifies the relation between the natural environment and man's technical and economic activities by claiming that

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[29] Karl August Wittfogel, "The Hydraulic Civilization," in *Man's Role in Changing the Face of the Earth*, ed. William L. Thomas with collaboration of Carl O. Sauer, Marston Bates, and Lewis Mumford (Chicago: Published for the Wenner-Gren Foundation for Anthropological Research / National Science Foundation by the University of Chicago Press, 1956), 155.

[30] Wittfogel, *Oriental Despotism*, 18; and Wittfogel, "The Hydraulic Civilization,"153.

[31] O. H. K. Spate, "The 'Hydraulic Society,'" *Annals of the Association of American Geographers* 49, no. 1 (Mar., 1959), 90-92.

[32] Wittfogel, *Oriental Despotism*, 18.

[33] Theodore Shabad, "Non-Western Views of the 'Hydraulic Society,'" *Annals of the Association of American Geographers* 49, no. 3, [Part 1] (Sep., 1959), 324. For a defense of Wittfogel's theories, see David H. Price, "Wittfogel's Neglected Hydraulic/Hydroagricultural Distinction," *Journal of Anthropological Research* 50, no. 2 (Summer, 1994): 187-204.

this relation is one-sided (with man passively responding to the natural setting)."[34] He added that the relationship between the environment and humans was a "two-way process [where] the ecological setting more often provides the possibility or probability, rather than the necessity for certain types of action."[35] On a different front, D. D. Kosambi challenged Wittfogel's perspective on the grounds that despotism is neither a product of "Orientalism, nor hydraulics, but the particular type of production: how much surplus is forcibly expropriated by the state for its own use and that of the class it mainly serves."[36] Kosambi's argument is based on the premise that despotism is not inherent in large-scale water management or in Asiatic societies, but depends on the relations of production.

Problematic for other scholars was Wittfogel's concept of *total power,* the idea that the state had complete control over society. Thomas Glick and Rene Millon, respectively, questioned Wittfogel's perspective on a despotic state by examining water management practices at medieval Valencia and pre-Columbian Teotihuacan.[37] In addition, Clifford Geertz, in *Negara: The Theatre State in Nineteenth-Century Bali,* identified how a collective societal consciousness towards managing water existed in Bali, a concept termed *consensual authority.*[38] Today, studies on water management are directed towards understanding the societal nuances of regulating water with little reference to Wittfogel's theories.[39]

Wittfogel's theories found fertile ground in Mexico. In particular, they shaped

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[34] Karl A Wittfogel, "Results and Problems of the Study of Oriental Despotism," *Journal of Asian Studies* 28, no. 2 (Feb., 1969), 361.
[35] *Ibid.*
[36] Shabad, "Non-Western Views of the 'Hydraulic Society,'" 325.
[37] Thomas F. Glick, *Irrigation and Society in Medieval Valencia* (Cambridge: Belknap Press of Harvard University Press, 1970), 172-174; Rene F. Millon, "Irrigation at Teotihuacan," *American Antiquity* 20, no. 2 (Oct., 1954): 177-180.
[38] Clifford Geertz, *Negara: The Theatre State in Nineteenth-Century Bali* (Princeton: Princeton University Press, 1980), 42.
[39] Vernon L. Scarborough, *The Flow of Water: Ancient Water Systems and Landscapes* (Santa Fe: SAR Press, 2003), 19.

anthropologists Ángel Palerm's research on pre-Columbian water management.[40] More recent scholars has argued that Wittfogel's theories, alongside those of Julian Steward, allowed Ángel Palerm and others to champion a theory of social evolution in Mesoamerica.[41] Thus, in central pre-Hispanic Mexico, large-scale agricultural irrigation was a means to explain the origins of civilization.[42] Significantly, Palerm's work became the basis for a Mexican anthropological framework by which to understand the relationship between water management and societies.

Agriculture has thus been the central optic for studying water and society. Mexican anthropologists have centered their studies on pre-Columbian water management for the purposes of comprehending agricultural irrigation, and indeed, this line of investigation is one method for addressing the use of water in Mesoamerica. But in this dissertation, I offer a different perspective. Employing the studies presented by Palerm and those of his colleagues such as Armillas and Wolf on pre-Columbian irrigation and agriculture, but without recourse to overarching theories of social evolution and the Asiatic mode of production, I scrutinize water management at Tenochtitlan for how it influenced the form of the island city.[43] A case in point: the pre-Columbian floods of 1429 and 1449, respectively, were the impetus for building hydraulic structures that would protect the Aztec capital from inundations. With these devices, which provided the Aztec the means to regulate the ebb and flow of the lakes, they transformed the lacustrine environment into a constructed aquatic setting. Equally as important, a stable human-made environment helped them to overcome one of the island's shortcomings: the lack of

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[40] Ángel Palerm, *Agua y agricultura: Ángel Palerm, la discussion con Karl Wittfogel sobre el Modo Asiático de Producción y la construcción de un modelo para el estudio de Mesoamérica*, ed. Alba González Jácome (Mexico City: Universidad Iberoamericana, 2007).

[41] Jacinta Palerm Viqueira, "Sistema hidráulicos y organización social: La polemica y los sistemas de riego del Acolhuacan septentrional," *Mexican Studies/Estudios Mexicanos* 11, no. 2 (Summer, 1995), 165.

[42] *Ibid.*

[43] Although Palerm's work differs from mine, his reconstruction of the Aztec hydraulic network via analysis of the earliest colonial chronicles aids its understanding.

land for expansion. Their method for enlarging the island—at least five-fold by the time of Spanish arrival in 1519—was by reclaiming land from the lakes via the *chinampa*—human-made island reclaimed from the lakes. Not coincidentally, they employed the same technology used in constructing agricultural *chinampas*. Surprisingly, *chinampas*, *chinampa* technology, and flood prevention elements such as dikes, causeway, dams, and floodgates, have only on rare occasions been viewed as a construction factor influencing the city's urban form.[44]

Colonial Water Management and Urban Form

Absent from any study of sixteenth- and seventeenth-century Mexico City is a detailed examination of its urban form in relation to the lacustrine environment. Architectural historians have primarily focused their attention on the Spanish portion of the city. Like many other colonial Latin American cities, Mexico City was founded on Renaissance theories of urban planning, as evidenced by its central plaza and orthogonal city plan. These urban planning principles, first proposed by Vitruvius in antiquity and later codified by Spanish authorities in 1573 as the *Ordenanzas de descubrimiento, nueva población y pacificación de las Indias*, were the guiding framework behind the design of Spanish cities in the New World.[45] Urban historians

[44] Sonia Lombardo de Ruiz, "El desarrollo urbano de México-Tenochtitlan," *Historia Mexicana* 22, no. 2 (Oct.–Dec., 1972): 121-141. Lombardo de Ruiz offers a general, but brief description of how these hydraulic elements may have influenced the city's form. On the other hand, Luis González Aparicio provides explanation of hydraulic elements surrounding the city and presents a plan of the region with these elements in pre-Columbian times. It is a body of work not unlike Palerm's reconstruction of the area's hydraulic network. See Luis González Aparicio, *Plano reconstructivo de la region de Tenochtitlan*, 3rd ed. (Mexico City: Instituto Nacional de Antropología e Historia, 1988).

[45] For an understanding of the Spanish planning ordinances, see "Ordenanzas de descubrimiento, nueva población y pacificación de las Indias," in *Recopilación de leyes de los reynos de las Indias: Estudios Histórico-Jurídicos*, ed. by Francisco de Icaza Dufour (Mexico City: Miguel Ángel Porrúa, 1987), 5:257-312. For additional studies on the gridiron plan in the New World, refer to: George Kubler, "Mexican Urbanism in the Sixteenth Century," *Art Bulletin* 24 (1942): 160-171; Dan Stanilawski, "Early Spanish Town Planning in the New World," *Geographical Review* 37 (1947): 94-105; Dan Stanilawski, "The Origin and Spread of the Grid-Pattern Town," *Geographical Review* 36 (1946): 105-120; Dora Crouch, Daniel Garr, and Axel Mundigo, *Spanish City Planning in North America* (Cambridge: MIT Press, 1982); Daniel J. Garr, ed., *Hispanic Urban Planning in North America* (New York: Garland Pub., 1991); Zelia Nuttall, "Royal Ordinances Concerning the Laying out of New Towns," *Hispanic*

have rightly drawn attention to Mexico City's Renaissance-inspired city plan.[46] But in doing so, they have tacitly ignored its pre-Hispanic hydraulic tradition and aquatic setting as factors influencing the architectural character of this island settlement.

Mexico City is strikingly different from any other Spanish colonial city. It was founded on a densely settled island that was prone to flooding, crisscrossed by canals, and requiring hydraulic structures to protect it from inundation. No other Spanish American city was planned in the middle of a lake. Although other settlements in the Spanish New World had hydraulic structures, these paled in comparison to the water management network the Spanish inherited from the Aztec.[47] In order to produce a city on European urban planning principles, the Iberians had to address the aquatic condition of their island site, and its Aztec infrastructures, to solve the perennial problem of flooding.

Scholarship on the *desagüe* has failed to explicate how this flood control method transformed the island of Mexico City to a mainland settlement. Study of the *desagüe* in its colonial manifestation falls into two categories: descriptive narratives written in Spanish and thematically oriented histories in English. The former need not be described individually. Their importance can be summarized briefly.[48] They undertake to recount a single-threaded narrative

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American Historical Review 4 (1921): 743-753; and Robert C. Smith, "Colonial Towns of Spanish and Portuguese America," *Journal of the Society of Architectural Historians* 14 (1955): 3-12.

[46] On Mexico City's city plan, consult Manuel Sánchez y Carmona, *Traza y plaza de la Ciudad de México en el siglo XVI* (Mexico City: Tilde Editores,1989); Lucía Mier y Terán Rocha, *La primera traza de la Ciudad de México, 1524-1535*, 2 vols. (Mexico City: Universidad Autónoma Metropolitana / Fondo de Cultura Económica, 2005); and Ana Rita Valero de García Lascuráin, *La Ciudad de México-Tenochtitlán: su primera traza, 1524-1534* (Mexico City: Editorial Jus, 1991).

[47] Examples of hydraulic projects in colonial Latin America can be found in Ignacio González Tascón, ed., *Obras hidráulicas en América colonial* (Madrid: Ministerio de Obras Públicas, Transportes y Medio Ambiente de Estudios y Experimentación de Obras Públicas / Centro de Estudios Históricos de Obras Públicas y Urbanismo, 1993).

[48] Francisco de Garay, *El Valle de México: apuntes históricos sobre su hidrografía, desde los tiempos mas remotos hasta nuestro dias* (Mexico City: Oficina tip. de la Secretaría de Fomento, 1888); Junta Directiva del Desagüe de Valle de México, *Memoria histórica, técnica, y administrativa de las obras del desagüe de Valle de México, 1449-1900*, 2 vols. (Mexico City: Tip. de la Oficina Impresora de Estampillas, 1902); Roberto Rios Elizondo, *Memoria de las obras del sistema de drenaje profundo del Distrito Federal*, 4 vols. (Mexico City: Secretaría de Obras y Servicios del Distrito Federal, 1975); Jorge Gurría Lacoix, *El desagüe de Valle de Méxioco durante la época*

of the *desagüe,* explaining the geographical, administrative, and engineering challenges of drainage. While important to our understanding of this earthwork project, they are a type of history that presents the *desagüe* as monolithic. It must remain for the reader of the present study to appraise the value of the additional dimensions offered in what follows. Lastly, no study on the *desagüe* can forgo mention of the *Relación universal*, an indispensable 1637 Spanish compilation of primary sources that offer detailed information on the drainage project's history.[49]

In English, understanding of the *desagüe* is limited. No book on the subject exists. Only two dissertations and a handful of essays make drainage their subject. In 1972, Louisa Schell Hoberman produced "City Planning in Spanish Colonial Government: The Response of Mexico City to the Problem of Floods, 1607-1637" in political science at Columbia University.[50] Primarily concerned with how flooding was a bureaucratic problem, she aptly pointed out how flood control engendered many conflicts between the branches of colonial government. However, her timeframe (1607-1637) was too short to provide a comprehensive account of urban change. More recently, Vera Silvina Candiani wrote "Draining the Basin of Mexico: Science, Technology, and Society, 1608-1808" for her Ph.D. in history at the University of California, Berkeley.[51] With respect to the seventeenth century—the timeframe that coincides in our

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novohispana (Mexico City: Universidad Nacional Autónoma de Mexico, 1978); and Emma Pérez-Rocha, *Ciudad en peligro: probanza sobre el desagüe general de la Ciudad de México, 1556* (Mexico City: Instituto Nacional de Antropología e Historia. 1996).

49 Fernando de Cepeda, Fernando Alfonso Carrillo and Juan de Alvarez Serrano, *Relación universal, legítima, verdadera, del sitio en que está fundada la muy noble, insigne, y muy leal Ciudad de México, cabeza de las provincias de toda la Nueva España. Lagunas, rios, y montes que la ciñen y rodean. Calzadas que las dividen y acequias que la atraviesan. Inundaciones que a padecido desde su Gentilidad. Remedios aplicados. Desagües propuestos, y emprendidos. Origen y fábrica del de Huehuetoca, y estado en que hoy se halla. Imposiciones, derramas, y gastos que se han hecho. Forma con que se ha actuado desde el año de 1553. Hasta el presente de 1637.* In *Obras públicas en México: documentos para su historia*, ed. Francisco González de Cosío, vol. 1 (Mexico City: Secretaría de Obras Públicas, 1976.

50 Louisa Schell Hoberman, "City Planning in Spanish Colonial Government: The Response of Mexico City to the Problem of Floods, 1607-1637" (PhD diss., Columbia University, 1972).

51 Vera Silvina Candiani, "Draining the Basin of Mexico: Science, Technology, and Society, 1608-1808" (PhD diss., University of California, Berkeley, 2004).

respective dissertations—Candiani links Carmelite friar Andrés de San Miguel's 1631 *desagüe* proposal to scientific and abstract mathematical thought. In addition to these dissertations, several articles help to supplement our knowledge of the drainage project. These, however, I scrutinize in the introduction to Chapter 4, as a means to highlight the importance of the seventeenth-century Dutch hydraulic engineer Adrian Boot and his flood control proposals for colonial Mexico City.

The Causality of a "Good Cataclysm"

Understanding the natural environment is essential for historicizing the flood control practices of the Aztec and Spanish. Building on environmental history's premise that interrelationships between human beings and nature exist, I examine how the urban form of these cities was constantly adapting to the changing conditions of the lakes. Independently of this perspective, two theoretical ideas were initial stepping-stones at the earliest stage of this dissertation. In philosophy, Immanuel Kant's comments on the 1755 Lisbon earthquake were helpful for conceiving disasters as not only catastrophic manifestations of the natural environment, but more importantly, as potential providers of "unexpected benefits," an aperçu resembling *Annales* historian Marc Bloch's concept of the "good cataclysm."[52] In *The Historian's Craft*, Bloch argued that a "good cataclysm" can be of great benefit to the historian. He pointed out that the eruption of Vesuvius in 79 A.D., which buried the town of Pompeii, preserved it for the inquiries of modern-day scholars.

Concepts like "unexpected benefits" and "good cataclysm" have fallen outside the purview of scholarship of pre-Columbian and colonial water management. Yet they are helpful

[52] Marc Bloch, *The Historian's Craft*, trans. Peter Putnam (New York: Alfred A. Knopf, 1953), 75.

aids for considering environmental disasters above and beyond traditional narratives of destruction, catastrophe, and loss: in short, their negative impact. With Kant's and Bloch's concepts in mind, I began considering what were the "benefits" and "good" aspects of flooding, if any. Determining these in the way that Kant or Bloch wrote about earthquakes and volcanic eruptions, respectively, did not initially lead to fruitful conclusions about Tenochtitlan and Mexico City. Nonetheless, I was always mindful of their concepts.

Implicit in their theories on catastrophes is the notion of causality—the relationship between an event and a second event as the consequence of the first. Thinking about catastrophic inundation in terms of causality set the stage for considering what may have been the "second event" after flooding. The Aztec and Spanish required a solution to inundations. In this respect, they were no different. However, each took a different approach to combating deluges. The pre-Columbians chose control, co-existence, and regulation, while the Iberians preferred elimination via drainage. These are two fundamentally different approaches to the chronic problem of flooding. Ultimately, while Tenochtitlan was made with water in mind, Mexico City could not coexist with the lakes.

Dissertation Outline

"The Hydrographic City" is organized into five chapters that are sequenced chronologically, spanning from the pre-Columbian period through the seventeenth century. Chapter One, "A City of Water," examines the aquatic nature of Tenochtitlan. It explicates the cosmological origins of the city's founding in relation to water. Secondly, it describes how this metaphysical idea of the city was made manifest. The aquatic character of the city is examined through the analysis of three images: folio 2r of the *Codex Mendoza*, *Plano en papel maguey*, and the *Nuremberg Map*. The images aid understanding how water the spatial arrangement of the city.

Chapter Two, "Indigenous Commentary on Sixteenth-Century Mexico City," takes as its subject a single colonial Indian-made map. The *Uppsala Map* depicts viceregal Mexico City ca. 1550. It provides us with the first historical image depicting the Spanish city. By examining a single narrative figure that in pose and location is unlike any other depicted in the map, I demonstrate how the *tlacuilo* presented the capital for inspection. I question the prevailing historiographical narrative that the Spanish city has been spatially uniform since the early 1520's, an argument substantiated by city council decrees. I contextualize this argument with the concepts of *policía*—the virtue of living a Christian way of life within spatial regularity—and *vivir alárabe*—non-Christians living in irregular settlement patterns. The examination of the *Uppsala Map* aids understanding of the architectural character of the Spanish city just a few years prior to the first colonial floods.

Chapter Three, "Mapping Drainage, 1552-1607" examines how flooding brought about a new colonial sensibility towards water management. With the inundations of 1552 and 1553, the Spanish took to repairing the hydraulic network. However, this newfound awareness did not directly translate into its wholesale acceptance. With the flood of 1555, the idea of the *desagüe* was born, but not implemented. I analyze the reasons why drainage was rejected at this time, and in addition, why the colonial authorities chose not to institute it with the floods of 1580 and 1604. The second half of this chapter examines Enrico Martínez' *desagüe* proposal of 1607 and his map, *Descripción de la comarca de México i obra del desagüe de la laguna* of 1608. With respect to the former, I shed light on how a shift in analyzing the cost of flooding made drainage feasible. Interpreting the map demands departing from Indian mapping methods to consider the role of European Renaissance cartography in Spanish flood control. I argue that *Descripción de la comarca de México* represents a new stage in flood control efforts at Mexico City. Martínez' map is the first drawing made in the service of flood control by a professional European mapmaker. I explicate how and why Martínez, trained in the latest technologies of cartography—science and mathematics—subjects drainage to rational analysis in an attempt to overcome the challenges presented by the city's natural surroundings.

Chapter Four, "In the Art of My Profession," examines the flood control proposals of the Dutch hydraulic engineer Adrian Boot. Historiographically speaking, Boot has been treated as a secondary figure to Enrico Martínez. Until now, no detailed study has been produced of the Dutchman. In this chapter, I explicate why Boot rejected drainage as a solution to Mexico City's chronic flood problems. I review the reasons why Boot, arguing that drainage would never end flooding, proposed to regulate the lakes using Dutch hydraulic technology. However, the capital's environmental character was unlike those found in the Low Countries, preventing the wholesale introduction of Boot's method, thus I present how Boot reimagined his homeland's technology to meet the social and environmental needs of viceregal Mexico City.

Chapter Five, "In the Midst of Floodwaters, ca.1628-ca.1690," examines several images to address fundamental changes in colonial water management. It considers the (potential) application of a universal property tax to pay for drainage with reference to Juan Gómez de Trasmonte's *Forma y levantado de la ciudad de México* and *Planta y sitio de la Ciudad de México* ca. 1628. The former is also important for its utopian portrayal of the city in its natural setting. The flood of 1629-34 brought an end to any lingering debate about the flood control approaches of Martínez and Boot and was the impetus for a new approach to combat inundations: to convert the *desagüe* tunnel to a canal. I examine the geometric drawing of

Carmelite friar Andrés de San Miguel to demonstrate how the conversion came under the scrutiny of Euclidian geometry. Finally, I examine *La mui noble y leal Ciudad de México* ca. 1690 to demonstrate how it presents a picture of environmental change when impressing upon the viewer that Mexico City is now a mainland settlement—a change in which the challenges posed by Mexico City's natural setting and its historical path of development had been overcome by the *desagüe*.

Chapter 1:

A City of Water

"A City of Water" scrutinizes the relationship between the Aztec capital and water. First, I examine how water was a key factor in the architectural fabric of Tenochtitlan. In particular, I explore how Lake Texcoco was envisioned as a guiding force in the city's spatial organization when it was founded, and how this urban plan had cosmological associations. As significant, this chapter studies the character of the Aztec hydraulic network. I demonstrate how flooding, no matter how catastrophic, was viewed as part of a larger water management framework. The goal of the pre-Hispanic approach to managing water was to establish stable water levels. As a result, I examine the benefits of a controlled aquatic environment to *chinampa* agricultural production and how it allowed for urban expansion.

The Basin of Mexico and the Environmental Conditions for Flooding

The island site of Tenochtitlan (and later Mexico City) is located at the lowest point in the Basin of Mexico, an enclosed hydrographic unit with no natural outlet for water despite its elevation of 2,240 meters above sea level.[1] Today, the Basin of Mexico encompasses the states of México, Hidalgo, Tlaxcala, and Puebla, as well as Mexico City.[2] The basin (*cuenca* in Spanish) is the result of fifty million years of tectonic and volcanic activity, forming the Transmexican Volcanic Belt.[3] This naturally forming concavity is bounded by the Sierra Nevada on the east; the volcanic range of the Sierra Ajusco to the south; the Sierra Las Cruces to the

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[1] Ezcurra, *De las Chinampas a la Megalópolis*, 11-12.

[2] Rios Elizondo, *Memoria de las obras del sistema de drenaje profundo del Distrito Federal*, 1:43.

[3] Margarita Carballal Staedtler and María Flores Hernández, "Elemento hidráulicos en el lago de México-Texcoco en el Posclásico," *Arqueología Mexicana* 13, no. 68 (July-Aug. 2004), 28.

west; and the Pachuca range to the north, consisting of sierras and low-lying hills.[4] Mountains ranging upwards of 5,000 meters overshadow the island site, with its two most famous volcanoes, Popocatépetl and Iztaccíhuatl, having respective elevations of 5,465 and 5,230 meters. The area of the basin is approximately between 8,000 and 8,058 square kilometers and extends 120 kilometers from north to south and 70 kilometers from east to west.[5]

Until about 700,000 years ago, the Basin of Mexico was actually a valley with two natural outlets for water on its southern flank.[6] However, volcanic activity from the Chichinautzin volcano closed these channels.[7] Without natural drainage, the hydrographic character of the former valley was transformed. It became a receptacle for summer rains and snowmelt, as well as water from streams, springs, and rivers that descended from the surrounding hills, mountains, and volcanoes to the basin floor. Eventually, an aquatic environment developed. It consisted of a single sheet of water, running in a continuous chain from north to south and making up at least twenty percent of the "valley" floor, having an area of more than 1,000 square kilometers (Fig. 1).[8] However, due to the dry winter months, this large

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[4] William T. Sanders, "The Natural Environment of the Basin of Mexico," in *The Valley of Mexico: Studies in Prehispanic Ecology and Society*, ed. Eric R. Wolf (Albuquerque: University of New Mexico Press, 1976), 59; William T. Sanders, Jeffrey R. Parsons, and Robert S. Santley, *The Basin of Mexico: Ecological Processes in the Evolution of a Civilization* (New York: Academic Press, 1979), 81; Alfred P. Maudslay, "The Valley of Mexico," *Geographical Journal* 48, no. 1 (Jul., 1916), 13; and Ezcurra, *De las Chinampas a la Megalópolis*, 12.

[5] Sanders, "The Natural Environment of the Basin of Mexico," 59; W. Michael Mathes, "To Save a City: The Desagüe of Mexico-Huehuetoca, 1607," *The Americas* 26, no. 4 (Apr., 1970), 419; Lacroix, *El desagüe del Valle de México durante la época novohispana*, 6. Ángel Palerm, *Obras hidráulicas prehispánicas en el sistema lacustre del Valle de México* (Mexico City: Instituto Nacional de Antropología e Historia / Centro de Investigaciones Superiores Seminario de Etnohistora, 1973), 17. These figures are not universally accepted, Ezcurra posits the area of the basin to be 7,000 square kilometers. See *De las Chinampas a la Megalópolis*, 12.

[6] Today, the basin is still referred to as a valley.

[7] These outlets drained southeast towards the city of Cuautla and southwest to the city of Cuernavaca, respectively. Margarita Carballal Staedtler and María Flores Hernández, "Hydraulic Features of the Mexico-Texcoco Lakes during the Postclassic Period," in *Precolumbian Water Management: Ideology, Ritual, and Power*, ed. Lisa J. Lucero and Barbara W. Fash (Tucson: University of Arizona Press, 2006), 156.

[8] Tesesa Rojas Rabiela, "Las cuencas lacustres del Altiplano Central," *Arqueología Mexicana* 13, no. 68 (July-Aug. 2004), 23-26; and Guadalupe de la Lanza Espino and José Luis García Calderón, "La cuenca de México," in *Lagos y presas de México*, ed. Guadalupe de la Lanza Espino and José Luis García Calderón (Mexico City: Centro de Ecología y Desarollo, 1995), 28; and Palerm, *Obras hidráulicas prehispánicas*, 17.

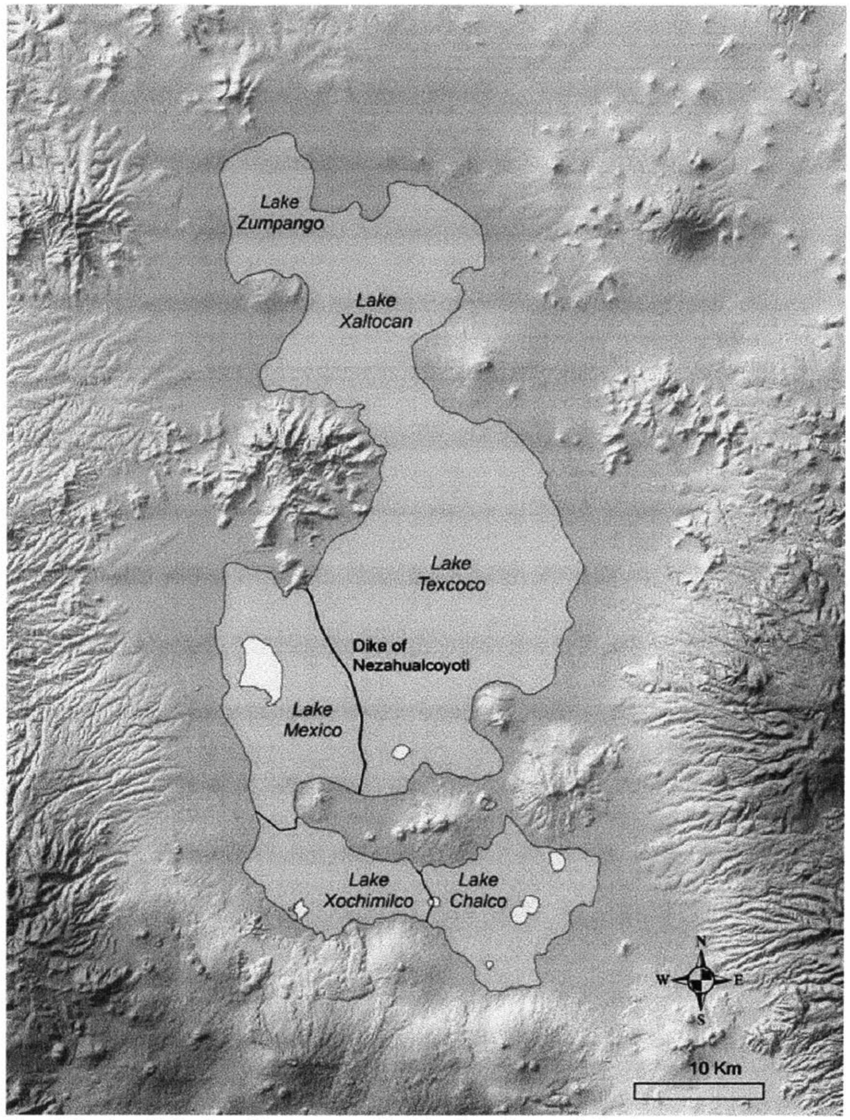

Fig. 1 Basin of Mexico. (Image provided by Greg Luna Golya.)

lake was reduced into several bodies of water until the next rainy season. In particular, the northern lakes would be separated from the central and southern ones.[9] With the aid of pre-Columbian hydraulic structures, the lacustrine environment was organized into six lakes. Lakes Xaltocan and Zumpango were located in the northern zone of this aquatic region. Lakes Texcoco and Mexico sat in the center and lakes Xochimilco and Chalco occupying the southern portion of

[9] John P. Bradbury, "Paleolimnology of Lake Texcoco, Mexico: Evidence from Diatoms," *Limnology and Oceanography* 16, no. 2, G. Evelyn Hutchinson Celebratory Issue (Mar., 1971), 181.

Table 1. Elevation of Lakes

Lake Zumpango	6 meters
Lake Xaltocan	3 meters
Lake Texcoco	0 meters
Lake Mexico	.85 meters
Lake Xochimilco	3.0 meters
Lake Chalco	3.5 meters

the lacustrine environment.[10] Although connected, the lakes of Chalco and Xochmilco were partially separated from the rest of the lakes by the Santa Catarina, a small volcanic sierra.[11] The lakes were all shallow, having a depth of one to three meters and although Lake Texcoco was the largest of the six, covering an area between 500 and 600 square kilometers, it had the lowest elevation among them (Table 1).[12]

The rainy season in the Basin of Mexico is from May to October. Eighty to ninety percent of the basin's rainfall occurs during this period.[13] The *cuenca* has eleven hydrological zones with a majority of its rivers being seasonal, except for the Magdalena, Mixcoac, Tacubaya, Hondo, Tlalnepantla, Cuautitlán, Tepotzotlán, San Juan Teotihuacán, and La Compañia, which

[10] Sanders, "The Natural Environment of the Basin of Mexico," 60; and Sanders, Parsons, and Santley, *The Basin of Mexico*, 84.
[11] Josefina García Quintana and José Rubén Romero Galván, *México Tenochtitlan y su problemática lacustre* (Mexico City: Universidad Nacional Autónoma de México, 1978), 28.
[12] Musset, "El Siglo de Oro del Desagüe de México, 1607-1691," in *Obras hidráulicas en América colonial*, ed. Ignacio González Tascón (Madrid: Ministerio de Obras Públicas / Transportes y Medio Ambiente de Estudios y Experimentación de Obras Públicas / Centro de Estudios Históricos de Obras Públicas y Urbanismo, 1993), 54; Sanders, Parsons, and Santley, *The Basin of Mexico*, 84; and Bradbury, "Paleolimnology of Lake Texcoco, Mexico," 181.
[13] Rios Elizondo, *Memoria de las obras del sistema de drenaje profundo del Distrito Federal*, 1:49.

run year round.[14] During the rainy season, the Cuautitlán River, which originates in the northwestern side of the basin has played an all too important role in altering the levels of the lakes for the worse. This river alone was the root of flooding, capturing rainfall from the Sierra Las Cruces to eventually deposit its rain-engorged waters into Lake Zumpango. The surplus water would then overflow this northernmost lake, triggering a chain reaction of rushing water toward the lower-lying lakes. They would eventually reach the centrally positioned Lake Texcoco, spilling its waters over the pre-Columbian dike of Nezahualcóyotl into Lake Mexico to flood the island site.[15]

Founded on Water

In ca. 1064, according to legend, the Aztec left their island homeland of Aztlán. They were a semi-nomadic tribe that eventually settled in the Basin of Mexico in 1248.[16] Upon their arrival in the basin, they were granted permission to live at the mainland site of Chapultepec, but were eventually expelled in 1299. Thereafter, they went to Tizaapan, but were also banished in 1325. On April 13, 1325, no longer granted permission to have a land base by the other more established Indian groups, the Aztec settled an unoccupied island near the western shores of Lake Texcoco to found Tenochtitlan.

Perhaps no image better aids comprehending the earliest beginnings of Tenochtitlan than folio 2r of the *Codex Mendoza* (Fig. 2). The codex is a post-conquest manuscript believed

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[14] *Ibid.*, 1:51.

[15] García Quintana and Romero Galván, *México Tenochtitlan y su problemática lacustre*, 66.

[16] Edward Calnek, "Tenochtitlan-Tlatelolco: The Natural History of a City / Tenochtitlan-Tlatelolco: La historia natural de una ciudad," in *El urbanismo en Mesoamérica = Urbanism in Mesoamerica*, ed. William T. Sanders, Alba Guadalupe Mastache, and Robert H. Cobean, vol. 1 (Mexico City: Instituto Nacional de Antropología e Historia; University Park: Pennsylvania State University, 2003-08), 1:151.

commissioned by Viceroy Antonio de Mendoza around 1533.[17] It comprises 71 folios. Importantly, these sixteenth-century pages provide pictorial and textual accounts of Tenochtitlan, conquered towns and tribute payments, and Aztec daily life.[18] Destined for Spain, perhaps that it be seen by Charles V, the codex was captured by French privateers, eventually ending up in the hands of the French cosmographer André Thevet, whose name appears at the top of the folio.[19] Five times Thevet wrote his name on the codex and twice with the year 1553. Today, the codex can be found in the collection of the Bodleian Libraries.

Illustrated on European paper, folio 2r was made by an anonymous *tlacuilo*. The image fuses pre-Hispanic cartographic elements with European perspective. The folio is framed by a calendric band composed of 51 squares. Each square correlates to a specific year by employing a combination of the pre-Columbian symbols—House, Rabbit, Reed, and Flint Knife—with the numbers 1 to 13. The combination of one of the four symbols with a number resulted in the identification of a year within the fifty-two-year Mesoamerican century. For example, in the upper left-hand corner, to the left of Thevet's signature, we find the symbols for "2 House,"—composed by the glyph for house and two circles above it—or 1325, the year that Tenochtitlan was founded.[20] The calendric frame is read in a counterclockwise direction and ends with the sign of "13 reed," or the year 1375.[21] Bounded by this calendric border, two scenes are depicted

[17] Francis F. Berdan and Patricia Rieff Anawalt, eds, *The Essential Codex Mendoza* (Berkeley: University of California Press, 1997), xii.
[18] Donald Robertson, *Mexican Manuscript Painting of the Early Colonial Period: The Metropolitan School* (Norman: University of Oklahoma Press, 1994), 96.
[19] Berdan and Rieff Anawalt, *The Essential Codex Mendoza*, xii; and Robertson, *Mexican Manuscript Painting*, 95.
[20] David Carrasco, "City as Symbol in Aztec Thought: The Clues form the Codex Mendoza," *History of Religion*, 20, no. 3 (Feb., 1981), 208.
[21] *Ibid.* See also Gordon Brotherston, *Painted Books from Mexico: Codices in UK Collections and the World They Represent* (London: Published for the Trustees of the British Museum by British Museum Press, 1995), 55; and Elizabeth Hill Boone, *Stories in Red and Black: Pictorial Histories of the Aztecs and Mixtecs* (Austin: University of Texas Press, 2000), 207.

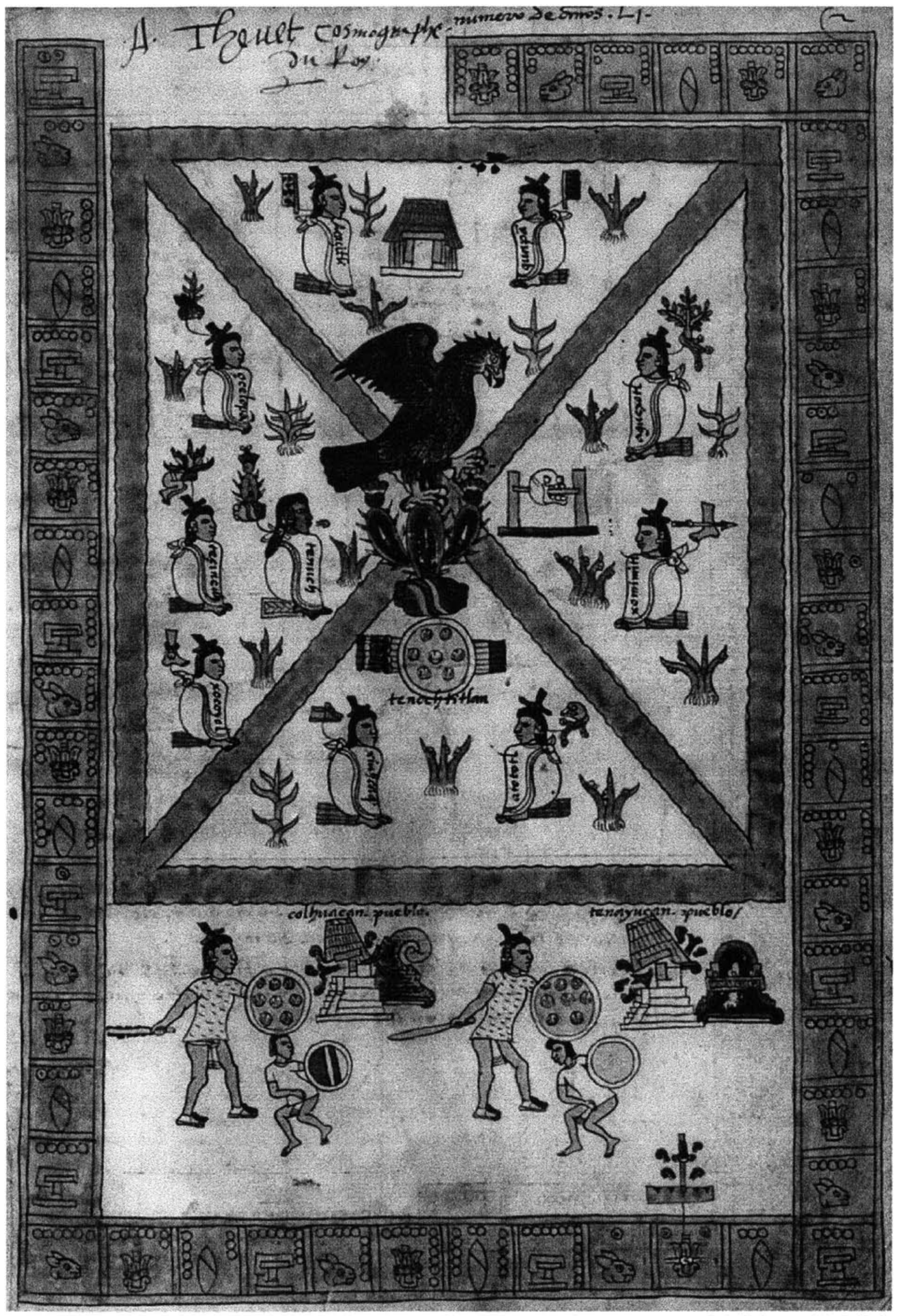

Fig. 2. Anonymous, Folio 2r of the *Codex Mendoza*, ca. 1533, water color on paper, 8 3/4 in. x 12 3/8 in. (22.3 x 31.5 cm). Bodleian Libraries, University of Oxford, Oxford. Shelfmark: MS. Arch. Selden. A. 1, fol. 2r. Photograph provided by the Bodleian Libraries, University of Oxford.

within the field of the folio. In the lower vignette, Aztec warriors with shields and *macanas* (flat elongated clubs with obsidian blades) are illustrated defeating the towns of Colhuacan and Tenayuca (to the left and right, respectively), indicated by bell-shaped glyphs behind and to the right of toppled-over burning temples.[22]

The upper scene represents the founding of Tenochtitlan.[23] At the center of the folio, an eagle perched on a prickly pear cactus grows from the pre-Columbian glyph for a rock.[24] The folio identifies ten male figures, the city's founders.[25] They wear the traditional white cloak (*tilmatli* in Classical Nahuatl). Nine are seated on bundles of green reeds. In marked contrast, the largest figure is depicted sitting on a yellow woven mat (Fig. 3). He wears black body paint with a smear of blood on his right temple, denoting bloodletting, his loosely tied hair and glyph for speech—appearing in blue by his mouth—signify his elevated status as a high priest, and as spokesperson for the other nine founders of city.[26] Importantly, the calendric band that frames the folio is a contiguous count of fifty-one years, illustrating the length of Tenoch's rule (1325-1375).[27] A war shield with seven eagle feathers and an equal number of spears (directly below the stone glyph) represents the sign for authority. Historian of religion Davíd Carrasco has argued that "war shield and eagle atop cactus with stone glyph" is the pictorial representation of

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[22] Berdan and Rieff Anawalt have noted that it was "highly improbable" that the Aztec could have defeated these communities within the early years of the settlement. Berdan and Rieff Anawalt, *The Essential Codex Mendoza*, 6. Interestingly, the indigenous artist employed three-dimensional space—seen in the spatial relationship between bell-shaped glyphs and temples and in the stance of the warriors—to depict this act of war.

[23] Davíd Carrasco, *Religions of Mesoamerica: Cosmovision and Ceremonial Centers* (San Francisco: Harper & Row, 1990), xxi. For a general introduction to the Mexico Tenochtitlan's foundation myth see Alfredo López Austin, *The Rabbit on the Face of the Moon: Mythology in the Mesoamerican Tradition*, trans. Bernard O. Ortiz de Montellano and Thelma Ortiz de Montellano (Salt Lake City: University of Utah Press, 1996), 51-60.

[24] Berdan and Rieff Anawalt, *The Essential Codex Mendoza*, 3-4.

[25] *Ibid.*, 4.

[26] *Ibid.*; and Carrasco, "City as Symbol in Aztec Thought," 210-211.

[27] Berdan and Rieff Anawalt, *The Essential Codex Mendoza*, 5.

Fig. 3. Tenoch, Folio 2r of the *Codex Mendoza* (Detail).

"Tenochtitlan has been founded and is the seat of authority."[28] In this narrative of authority, the native artist condensed time. It would not be until later that Colhuacan and Tenayuca would fall under Tenoch's reign, but by associating it to its foundation, it impresses upon the viewer that the city's preeminence began in 1325.

A second frame, in blue, presenting Lake Texcoco, lies on the folio. From the corners of this aquatic boundary, two waterways run diagonally across the island to make the shape of an "X." They intersect at the point where the eagle rests atop the cactus, a pictorial maneuver that highlights the idea of a monumental center (a theme to be discussed later in this chapter). The meeting of these waterways with the eagle serves to highlight how water was envisioned as part of the city since it was founded. Indeed, notice how the watercourses divide the island city into

[28] Carrasco, "City as Symbol in Aztec Thought," 211.

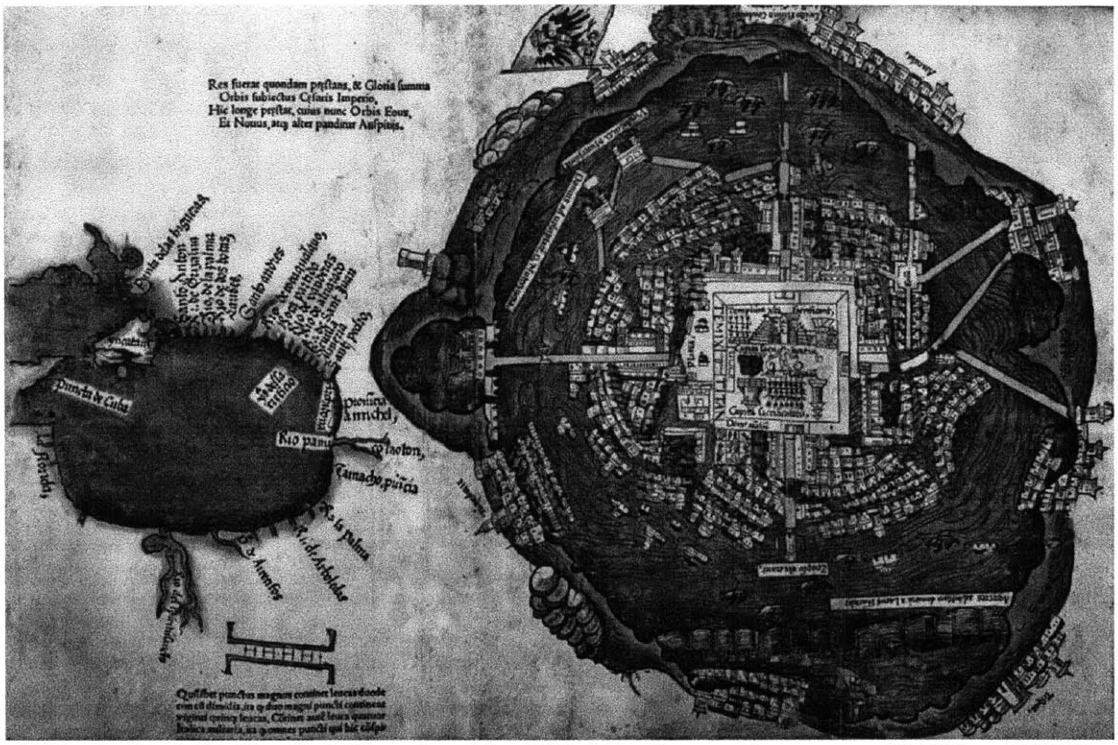

Fig. 4. Hernán Cortés (attributed to), *Nuremberg Map*, 1524, ink and watercolor on paper, 18 5/8 in. x 11 7/8 in. (47.30 x 30.16 cm). The Newberry Library, Chicago. Photograph courtesy of The Newberry Library, Chicago. Collection No. Ayer 655.51.C8.1524d.

quadrants.[29] The ten founders are each shown in one of the four sectors of the island. They represent original sectors of Tenochtitlan: Cuepopan, Atzaqualco, Moyotlan, and Teopan.

If we briefly turn our attention to the *Nuremberg Map*, we see how the city is organized into quadrants by an equal number of causeways (Fig. 4). (North on the map is to the left.) The watercourses that metaphorically defined the spatial organization of the island in the *Codex Mendoza* have now taken the form of four causeways in the *Nuremberg Map.* These extend from the midpoints of the ceremonial complex dressed in white on the map to the cardinal directions.[30] In Aztec thought, the earth took on the form of a "great cross."[31] With a square central mass and

[29] At least one scholar has posed the idea that these canals were intentionally made for drainage. See Brotherston, *Painted Books from Mexico*, 55.
[30] Carrasco, "City as Symbol in Aztec Thought," 216.
[31] *Ibid.*, 217.

four outward extending arms, this pre-Columbian version of a Greek-cross plan is elegant in its simplicity.

The folio thus highlights how water was the guiding force in the spatial organization of the city at the time of its founding. As important, the image describes the city's relationship to Lake Texcoco metaphorically. From the folio, we have no understanding as to the character of the lake, its area, or the quality of its water. We can only deduce two things about these bodies of water: one, that Lake Texcoco encircles Tenochtitlan, and two, that waterways divide the island into quadrants. In keeping with pre-Columbian pictorial practice, the folio describes these geographical features not in a literal sense, but as the cosmic authorization of historic events—in this case, the founding of Tenochtitlan.

"Land Surrounded by Water"

Tenochtitlan's spatial organization is a reflection of the cosmos. The idea of a four-part cosmological order is found in the frontispiece to the pre-conquest *Codex Fejérváry-Mayer* (Fig. 5). The image incorporates the pictorial styles of the Maya, Mixtec, and Nahua in representing the pre-Columbian universe. Like Tenochtitlan with its ceremonial precinct, the frontispiece has a central square. From it, four trapezoidal forms extend outward. These arms, representing the four regions of the cosmos, are directed to the four cardinal points (not unlike Tenochtitlan's causeways).[32] Mexican anthropologist Miguel León-Portilla has noted that the pre-Columbian "universe is divided into four well-defined directions, which although coinciding with the cardinal points, encompass much more than mere direction; each includes a whole quadrant of

[32] *Codex Fejérvary-Mayer: An Old Mexican Picture Manuscript in the Liverpool Free Public Museum (12014/M)*, elucidated by Dr. Eduard Seler, English edition by A. H. Keane (Berlin and London: Printed by T. and A. Constable, [late] Printers to Her Majesty at the Edinburgh University Press, 1901-02), 1:5.

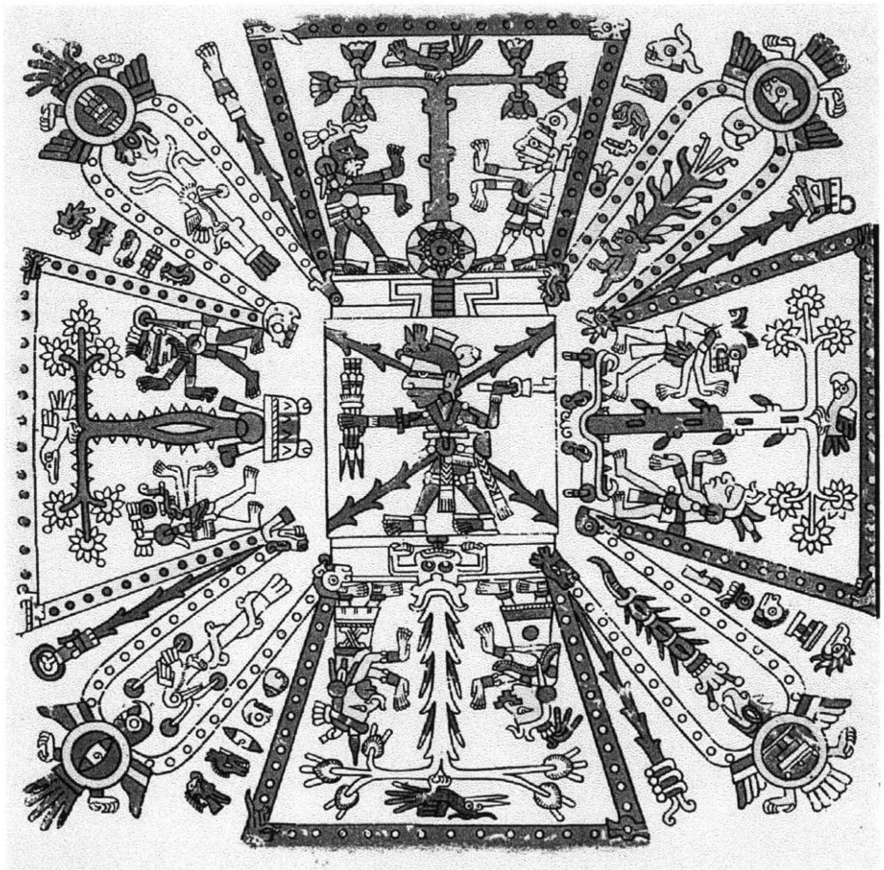

Fig. 5. Frontispiece, *Codex Fejérváry-Mayer*. Pre-conquest manuscript.

the universe."[33] Each quadrant is unique in its character, which we can understand from Table 2. The cosmological order of the pre-Columbian world can also be found in the concept of *cemanahuac*, the Classical Nahuatl word meaning "land surrounded by water." The *cemanahuac* comprises another natural element: the four directions of the wind, called *nauhcampas*, with each having its own color, god, and symbol. The character of the *cemanahuac* is recorded in Table

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[33] Miguel León-Portilla, *Aztec Thought and Culture: A Study of the Ancient Nahuatl Mind*, trans. Jack Emory Davis (Norman: University of Oklahoma Press, 1963), 46.

Table 2. The Four Directions of the Universe

Direction	Color	Characteristic	Symbol
North	Black	Region of the Dead	Flint
South	Blue	Region left of the Sun	Rabbit
East	Red	Fertility and Life	Reed
West	White	Land of Woman	House

Table 3. The Four Directions of the *Cemanahuac*

Direction	Color	God	Symbol
North	Black	Tezcatlipoca	Flint
South	Blue	Tezcatlipoca	Rabbit
East	Red	Tezcatlipoca	Reed
West	White	Quetzalcoatl	House

3.[34] Notice that no distinction exists between the colors and symbols associated with the respective directions of the cosmos and the *cemanahuac*. The four symbols associated with time in folio 2r's calendric frame are also characteristics of the pre-Columbian universe and the concept of *cemanahuac*. It is important to note that not only were the four sectors of the city called *nauhcampa*—as in the four directions of the wind—but also that Tenochtitlan was thought

[34] Carrasco, *Religions of Mesoamerica*, 71; Eduardo Matos Moctezuma, "Symbolism of the Templo Mayor" in *The Aztec Templo Mayor: A Symposium at Dumbarton Oaks, 8th and 9th October 1983*, ed. Elizabeth Hill Boone (Washington D.C.: Dumbarton Oaks Research Library and Collection, 1987), 186.

of as *cemanahuac*.[35] Thus we can begin to understand how an idea of *cemanahuac* was instilled in the blue aquatic frame that surrounds the island of Tenochtitlan.

A Monumental Center

If folio 2r represents an indigenous view of the founding of the Aztec capital, then the *Nuremberg Map* is its opposite. The *Nuremberg Map* illustrates the European gaze upon Tenochtitlan. It provides us with the earliest post-conquest image of the city, a visual aid that will help us to understand the fabric of the Aztec capital.[36] Although the map was published in 1524 in the German city of Nuremberg, three years after Aztec defeat, it presents us with an image of Tenochtitlan that (in theory) is unencumbered by the presence of its European conquerors. From high above the surface of the earth, we look down upon a city made of water.

The *Nuremberg Map* consists of two drawings. On the left, we find the Gulf of Mexico. On the right, the island city of Tenochtitlan is seen within its aquatic setting of Lake Mexico.[37] Hernán Cortés was believed to have authored the drawing from which the *Nuremberg Map's* woodcut was made. Undoubtedly, this premise was based on the fact that this drawing accompanied Cortés' *Second Letter* (of 1520) written to the Spanish monarch Charles V.[38] In total, the Spanish conquistador wrote five letters between 1519 and 1526 to his king.[39] Today, it

35 Carrasco, "City as Symbol in Aztec Thought," 217; and Matos Moctezuma, "Symbolism of the Templo Mayor," 186.
36 Until this point no other image of an "American" settlement is known in European circles, and perhaps more importantly, no image of a New World city had captured the European imagination as much, engendering copies for the next three centuries.
37 Art historian Elizabeth Hill Boone has noted that each image has gained the attention of a specific group of scholars. One the one hand, the drawing on the right commands the most interests from those concerned with Aztec Mexico, while the drawing on the left garners the attention of cartographic historians. Elizabeth Hill Boone, "This New World Now Revealed: Hernán Cortés and the Presentation of Mexico to Europe," *Word & Image* 27, no. 1 (Jan-Mar., 2011), 31.
38 Hernán Cortés, *Praeclara de Nova maris Oceani Hyspania Narratio*.... (Nuremberg: F. Peypus, 1524).
39 Hernán Cortés, *Letters from Mexico*, trans. and ed. Anthony Pagden (New Haven: Yale University Press, 1986). Interestingly, the map was not always published with the letter. For example, the publisher Jacob Crombreger

is generally agreed that Cortés did not make the original drawing.[40]

The *Nuremberg Map* is based on a fish-eye perspective. It provides the onlooker with a 360-degree view of the pre-Columbian city and its surrounding environs. The map fuses different types of projection—profile, perspective, and plan—into a singular frame. Yet its defining characteristic is its wide-angle view, valued for depicting large geographical areas such as cities. This type of projection gives the impression that the earth's surface is elastic, where space is depicted as elliptical, spherical, or curved. To better comprehend how the *Nuremberg Map* functions as a descriptive device, let us briefly turn our attention to two city views that employed the fish-eye projection.

In 1548, Conrad Morant produced the *View of Strasbourg* (Fig. 6). In it, we find a pronounced display of an elastic surface. Observe how the city's canals circulate around the periphery of the settlement, adhering to the ocular form of the image. Further highlighting the notion of an elastic surface, take note how city streets flex in the left-hand side of the image, as if conforming to the contours of the settlement's terrain. As the city stretches towards Strasbourg's periphery, built forms diminish in size as they near the edge. Yet upon closer inspection, the

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printed the *Second Letter*, in Seville, on October 8, 1522 without the map. It was not until 1524 that the image was published as a foldout plate in *Praeclara de Nova maris Oceani Hyspania Narratio* ..., the Latin translation of Cortes' *Second Letter*. See Boone, "This New World Now Revealed," 31.

[40] Art historian Barbara E. Mundy has made a case that the map's author was a *tlacuilo*. In "Mapping the Aztec Capital: The 1524 Nuremberg Map of Tenochtitlan, Its Sources and Meanings," she argues that *Nuremberg Map* derives from an "indigenous prototype" (13). Sadly, no map of Tenochtitlan is known to have survived the conquest, thus prohibiting a comparison between its pre-Hispanic image and the *Nuremberg Map*. In the absence of a pre-Columbian map of the city, Mundy took to conducting a comparative formal analysis between the *Nuremberg Map* and early post-conquest Indian-made maps and other pictographic sources, such as the *Lienzo de Tlaxcala* (c. 1550), a drawing from the Codex Boturini (c. 1530), and a plan on folio 269 from the *Primeros Memoriales* (c.1561), among others. In doing so, she identified similarities between the cartographic motifs in these later images and to those found in the *Nuremberg Map*. As a result of Mundy's analysis, the possibility exists that an Indian mapmaker may have produced the drawing on which the *Nuremberg Map* is based.

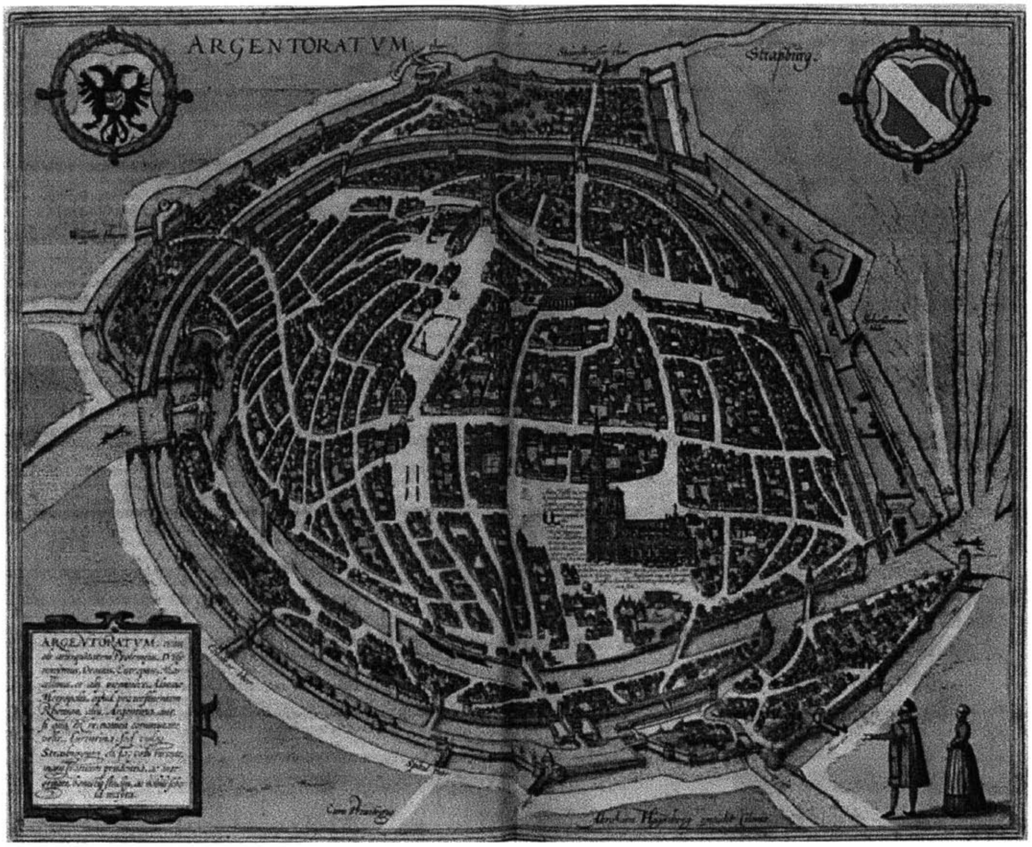

Fig. 6. Georg Braun and Abraham Hogenberg (after Conrad Morant) *View of Strasbourg*, 1599.

elastic surface does not encompass the entire settlement. In marked contrast to the sinuous form of city streets and city blocks, open spaces, and hydraulic elements, Strasbourg's city center alone reads as if resting on level ground. In doing so, the mapmaker draws the viewer's attention to Strasbourg's most important building, its cathedral. It is further emphasized by a textual description that wraps around this religious structure. It is a cartographic moment that monumentalizes Strasbourg's city center above all other structures and spaces, as Juergen Schulz stated in his analysis of the *View of Strasbourg*.[41]

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[41] Jürgen Schulz, *La cartografia tra scienza et arte: Carti e cartografia nel Renascimiento italiano* (Modena: F. C. Panini, 1990), 11-12. For analysis of the *Nuremberg Map*, employing Schulz' scholarship on the *View of Strasbourg*

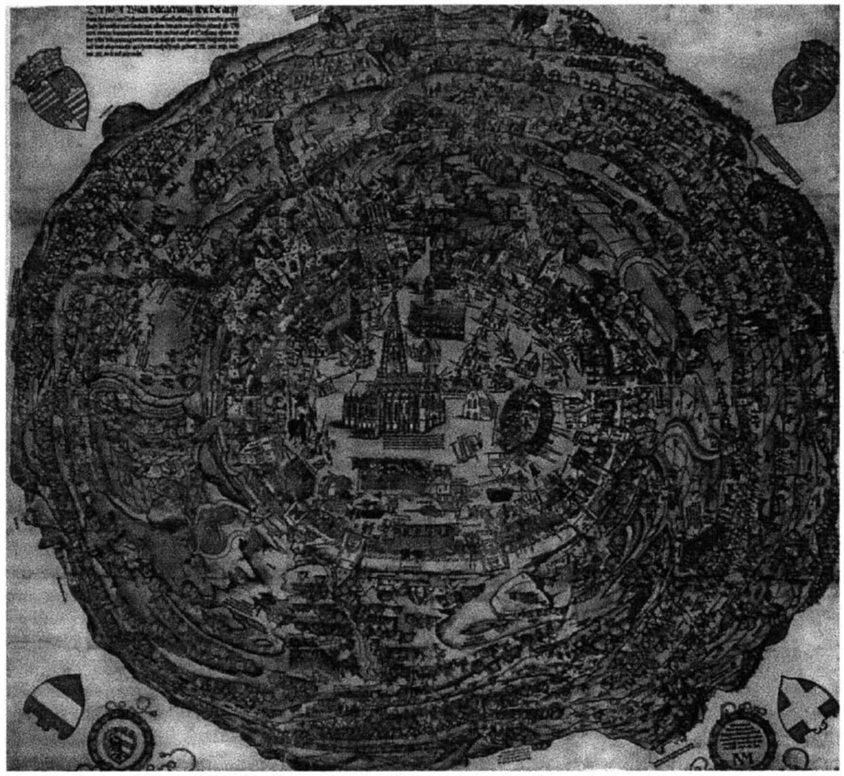
Fig. 7. Nicolaus Meldemann, *Siege of Vienna*, 1530.

Emphasis of a monumental center is also found in Nicolaus Meldemann's *Siege of Vienna* (Fig. 7). This city view was executed from a woodcut of six blocks. The image is based on a rendition by a local painter, who had climbed to the top of St. Stephen's Cathedral to document the Ottoman invasion of 1529.[42] Meldemann's image also evokes Schulz' idea of the "monumental center." We can easily locate the cathedral at the city's core and its nearby surrounding buildings resting on level ground. Yet, the further away our eye moves from the urban core, the more the landscape begins to rotate around the map's center. The terrain moves in a clockwise direction. The natural landscape is portrayed as a series of (implied) concentric

see Ricardo Padrón, *The Spacious Word: Cartography, Literature, and Empire in Early Modern Spain* (Chicago: University of Chicago Press, 2004), 128-129.

[42] David Landau and Peter Parshall, *The Renaissance Print, 1470-1550* (New Haven: Yale University Press, 1994), 227.

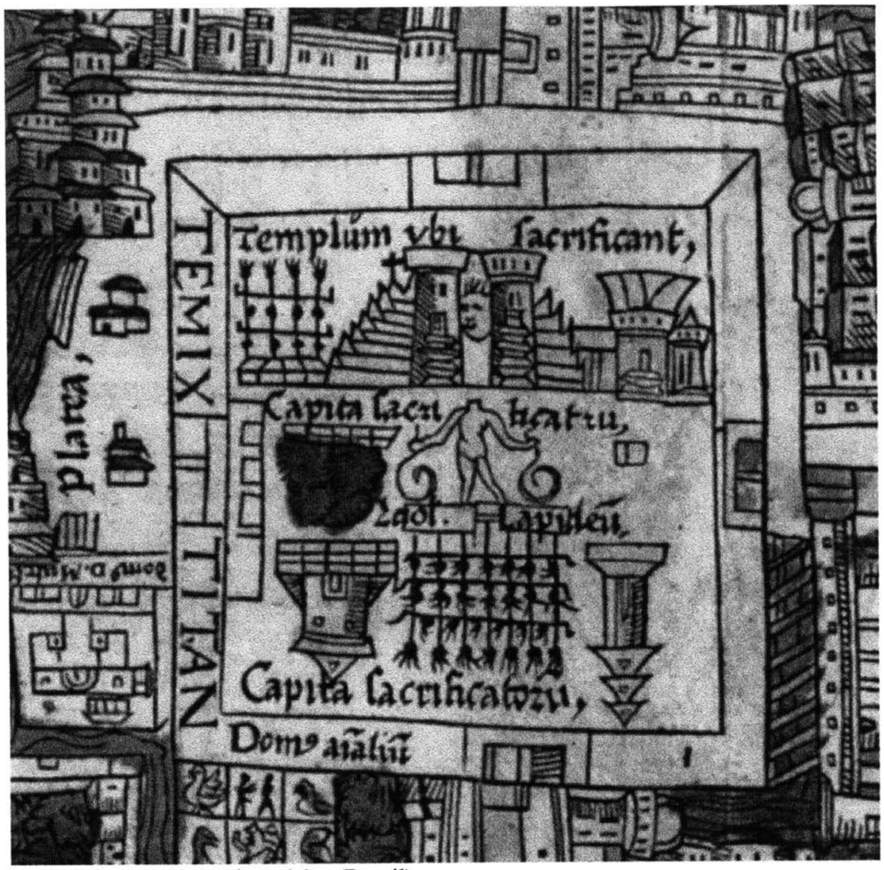

Fig. 8. *Tlaxico*, *Nuremberg Map* (Detail).

rings, identifying hills, trees, and buildings in relief. These rings give the impression that Vienna's natural terrain recedes from the city center until one's vision is unable to follow the curvature of the earth's surface.

With the idea of a monumental center in mind, we can now scrutinize the *Nuremberg Map*. Like its European counterparts, the indigenous city center occupies a prominent place in the map. Dressed in white, the Aztec ceremonial precinct—the *tlaxico*—is easily located (Fig. 8). The *tlaxico* is bounded on all sides by the *coatepantli*—the classical Nahuatl word for a "wall of serpents"— a thick masonry wall enclosure lined with serpent heads not unlike those found at the nearby pre-Columbian site of Tenayuca (Fig. 9). Reinforcing the idea of a monumental core,

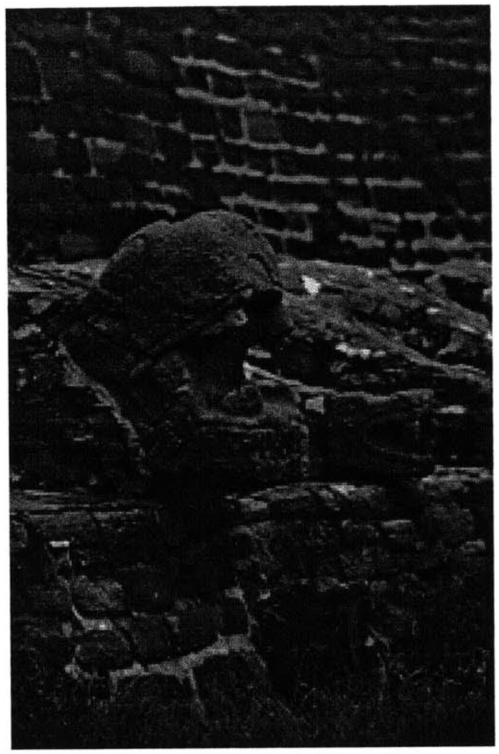

Fig. 9. Serpent Figures at Tenayuca. Photograph by John F. López.

this walled precinct occupies nearly every inch of the island.[43] Its suggested size easily overwhelms all other architectural structures, regardless of their aquatic or mainland setting. In reality, the *tlaxico* measured only 500 meters on each side.[44]

In the *Nuremberg Map*, hundreds of *chinampas* filled with homes with white walls and red-hued roofs encircle the centrally positioned ceremonial precinct.[45] A series of tan-colored bridges connect an alternating pattern of these artificial islets and canals to each other and to the island. At the outer fringes of the lake, a series of nondescript paddlers in one-, two- or three-person dugout canoes go about their daily task of ferrying goods and people to the island. Thin

[43] The exception being a relatively small area to the *tlaxico's* left, which is labeled *platca* or plaza in English or Spanish.

[44] Lombardo Ruiz, "Desarrollo urbano de México-Tenochtitlan," 139.

[45] Only three of the six lakes are depicted. Lake Mexico is the largest. Texcoco is shown towards the bottom, and Xochimilco as having a bulbous shape to the left. Omitted are the lakes of Zumpango, Xaltocan, and Chalco.

sinuous black lines capture the movement of water, impressing upon the viewer that Lake Mexico's waters rotate around a central core, not unlike how the countryside rotated around Vienna. One notes the ring-shaped organization of the *chinampas*, the rounded frame of Lake Mexico, the spherical articulation of water with thin black lines, the paddler and canoe encircling the city, and the roundness of the mainland.[46] These rings terminate gracefully with an undulating bold black line that frames the end of the aquatic region and the beginning of the mainland. From this point, dry land recedes into the background. As in its Viennese counterpart, the eye cannot follow beyond the horizon. In the *Nuremberg Map*, circularity does not emanate from topographic reality, but rather from the method of projection, The *View of Strasbourg* and the *Siege of Vienna* together demonstrate how the fish-eye projection underscores the idea of a monumental center in the *Nuremberg Map*. Unlike Strasbourg or Vienna, cities firmly resting on dry land, Tenochtitlan was different. The *Nuremberg Map* captures the amphibious nature of the city by depicting how it extended into the Lake of Mexico.

Pre-Columbian Water Management

Regulating the vast lacustrine environment comprising more than 1,000 square kilometers would be no easy task.[47] In the *Nuremberg Map*, observe how from the city center, three cream-colored causeways stretch across Lake Mexico to the mainland.[48] Going in a clockwise direction, the causeway (*calzada*) of Tacuba connects the island to the western shore of the mainland. The *calzada* of Tepeyac stretches northward to a location of the same name. The following causeway does not extend to dry land, but to an embarcadero, and culminates at a

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[46] Boone has also noted the radiating concentric rings in "This New World Now Revealed," 32-33.
[47] Rojas Rabiela, "Las cuencas lacustres del Altiplano Central," 23-26.
[48] For a schematic interpretation of the *Nuremberg Map*, see Justino Fernández's diagram in Toussaint, Gómez de Orozco, and Fernández, *Planos de la Ciudad de México, siglos XVI y XVII*, 97.

temple. It leads the viewer's attention to the lower half of the map, as if pointing to the pre-Columbian dike of Nezahualcóyotl. Finally, the causeway of Iztapalapa extends to Xochimilco in the southern region of the basin. To regulate the lakes, and by extension, to control flooding, the Aztec (and others) undertook the building of a complex hydraulic network.[49] It included causeways, dikes, canals, floodgates, dams, and redirected rivers. Aqueducts were another type of hydraulic structure primarily concerned with supplying water to the island.

The location of hydraulic elements determined their method of construction and material composition. For example, *calzadas* in an east-west direction, primarily found going from the island to the mainland, were made of earthen materials and had several openings spanned by bridges.[50] In marked difference, *calzadas* having a north-south alignment were made with more permanent, heavier materials such as stone, with very few openings.[51] The difference in the material makeup suggests that the *calzadas* of Tepeyac and Iztapalapa, for example, which had north-south orientation, also doubled as dikes.

Perhaps the best-known dike of the pre-Columbian period is that of Nezahualcóyotl (Fig. 10). In the lower half of the *Nuremberg Map*, this hydraulic element is represented as a series of interwoven reeds, with three openings serving as floodgates. In reality, it was made of stone and wood pylons. In 1449, Tenochtitlan suffered its second flood, twenty years after its first inundation. The Aztec *huey tlatoani* (leader), Moctezuma the Elder, called upon Nezahualcóyotl, the governor of Texcoco, for advice on how best to prevent flooding.[52] The latter, having

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[49] Carballal Staedtler and Hernández, "Hydraulic Features of the Mexico-Texcoco Lakes during the Postclassic Period," 160.
[50] *Ibid.*, 164.
[51] *Ibid.*
[52] José Luis Martínez, "Nezahualcóyotl 'Coyote Hambriento' (1402-1472)," *Arqueología Mexicana* 10, no. 58 (Nov.-Dec. 2002): 26; and Maudslay, "The Valley of Mexico," *Geographical Journal*, 14. Bradbury suggests that the dike also was intended to protect the "highly productive *chinampa* farms southwest of the capital." Bradbury, "Paleolimnology of Lake Texcoco, Mexico,"181.

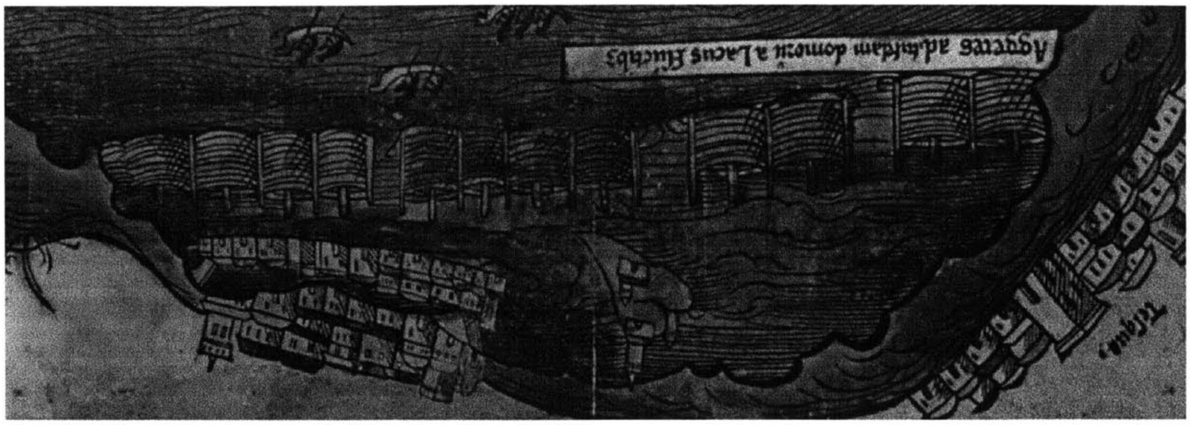

Fig. 10. Dike of Nezahualcóyotl, *Nuremberg Map* (Detail).

knowledge of hydraulics and already the builder of several water-related projects, suggested that a dike east of the city be built. It stretched from the southern mainland town of Iztapalapa to Atzacoalco in the north, having a length of 16 kilometers and a width of 7 meters.[53]

While the dike was intended to prevent future inundations, it had a noteworthy environmental impact on the lacustrine environment. The equilibrium between the lakes changed. The dike created Lake Mexico from Lake Texcoco. More importantly, the natural stream flows from the western side of the basin made Lake Mexico a fresh body of water, and by extension, more conducive to *chinampa* agricultural production.[54] In turn, and over time, Lake Texcoco became saline due to evaporation and the rich salt-mineral soils of nearby hills.[55]

One of the island's shortcomings was its lack of potable water. Without a natural source on the island, fresh water had to come from the mainland. Imagine, if you will, that the paddlers

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[53] Carballal Staedtler and Hernández, "Hydraulic Features of the Mexico-Texcoco Lakes during the Postclassic Period," 167. Martínez, "Nezahualcóyotl 'Coyote Hambriento' (1402-1472)," 26; Carballal Staedtler and Hernández, "Elemento hidráulicos en el lago de México-Texcoco en el Posclásico," 29; García Quintana and Romero Galván, *México Tenochtitlan y su problemática lacustre*, 81; and David J. Fox, "Man-Water Relationships in Metropolitan Mexico," *Geographical Review* 55, no. 4 (Oct., 1965), 526.

[54] Fox, "Man-Water Relationships in Metropolitan Mexico," 526.

[55] *Ibid.*

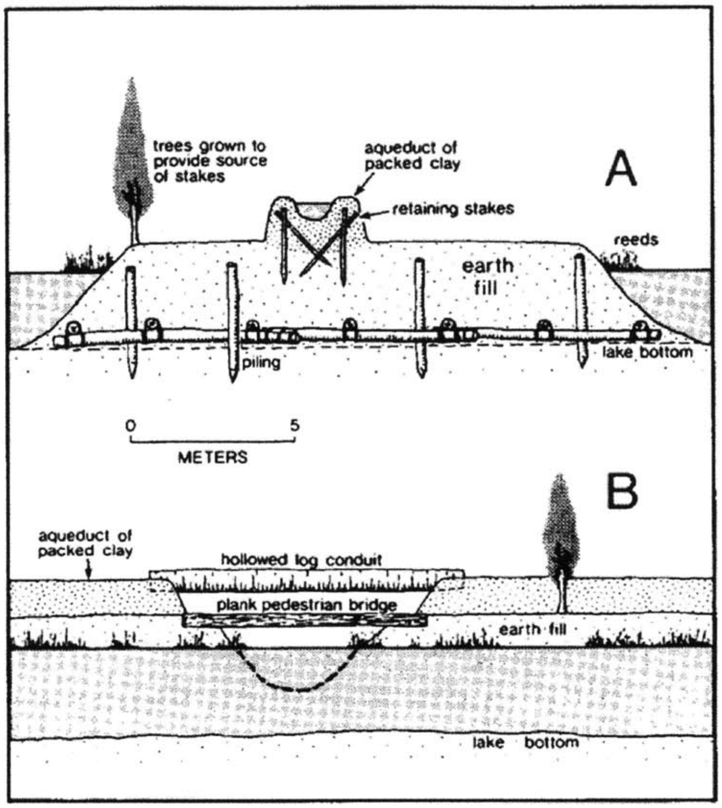

Fig. 11. 1418 Earthen Aqueduct (after Bribiesca Castrejón, 1958).

in the *Nuremberg Map* traverse Lake Mexico to deliver water to the city. It was a labor-intensive effort that could not cease. The alternative was for the inhabitants of Tenochtitlan to be consumed by thirst. To supply the city with a constant flow of water, in 1418 Chimalpopoca designed an aqueduct.[56] It channeled water from the mainland site of Chapultepec where a natural spring existed. From the following figure, we can understand the aqueduct's method of construction (Fig. 11). Reed mats, 7 to 8 meters wide, spaced 3 to 4 meters apart, were laid end-to-end from the mainland to the island. They were anchored into the lake with wooden stakes. Heavy materials such as mud, rock, and sod were added, making the mats sink to the bottom of the lake. The process of adding materials continued until a chain of artificial islands was made.

[56] William E. Doolittle, *Canal Irrigation in Prehistoric Mexico: The Sequence of Technological Change* (Austin: University of Texas Press, 1990), 121.

Upon these man-made islets, earthen troughs were constructed. Lined with clay to prevent seepage, they had an approximate dimension of 1 meter in height and 1.5 to 2 meters in width. Split, hollowed-out tree trunks would span the islands, carrying water to the next islet. Adjacent to the aqueduct, on a lower level, a plank bridge allowed for pedestrian traffic. The aqueduct provided water to the city through 1449, when the aforementioned flood destroyed it.

In 1465, Nezahualcóyotl designed a new aqueduct.[57] Like its predecessor, it also began at Chapultepec. It followed a course that today is the avenue of Melchor Ocampo, turning slightly eastward until reaching Ribera de San Cosme, the edge of the dry land. From the mainland it ran down the center of the causeway of Tacuba until reaching Tenochtitlan.[58] Nezahualcóyotl still retained the method of building artificial islands in a linear fashion with spacing between them, as we can deduce from the aqueduct's depiction in the *Nuremberg Map* (Fig. 12). This arrangement is also detectable in the causeway of Nonoalco (which parallels Tacuba to its left).[59] In the years since the first aqueduct had been built, the pre-Columbians had learned to improve its construction.

These man-made islands underwent important changes with respect to their design and construction (Fig. 13). First, the islets were not constructed to their 1418 dimensions; they were made wider, measuring between 10 and 12 meters across. Unlike the earlier use of an earthen trough lined with clay, the 1465 aqueduct now counted on stone masonry construction, a foundation, and a double-channel conduit. Regrettably, the engineer of the first aqueduct did not account for cleaning, maintenance, or repairs in the design; thus, when they were required, the

[57] García Quintana and Romero Galván, *México Tenochtitlan y su problemática lacustre*, 84.
[58] *Ibid.*, 85-86.
[59] It is of interest to note how both these causeways allow water to flow freely, a sign that floodwaters did not derive from the western side of the island.

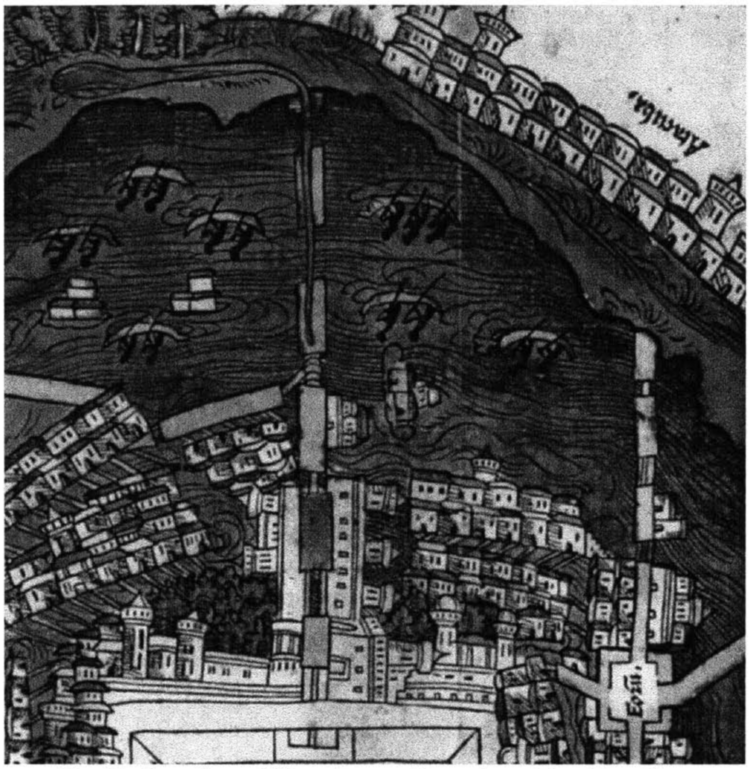

Fig. 12. Aqueduct of Chapultepec, *Nuremberg Map* (Detail).

flow of water to the city was interrupted. With the inclusion of a double-conduit system in the second aqueduct, the issue of maintenance was resolved: when one channel was inactive due to cleaning, the other would still be operational.[60] Each water channel was 57 centimeters deep, measuring 30 centimeters across at the interior of its base and 60 centimeters at its top.[61] In total, the aqueduct was 1.6 meters tall and 2.5 to 3.0 meters across at its top.[62]

The technological improvements of the 1465 aqueduct are impressive.[63] Masonry construction was far superior to its earthen predecessor. Likewise, the method of construction was labor-intensive it can only be compared to the manner in which pre-Columbian pyramids

[60] García Quintana and Romero Galván, *México Tenochtitlan y su problemática lacustre*, 85.
[61] Doolittle, *Canal Irrigation in Prehistoric Mexico,* 123.
[62] *Ibid.*
[63] *Ibid.*, 126.

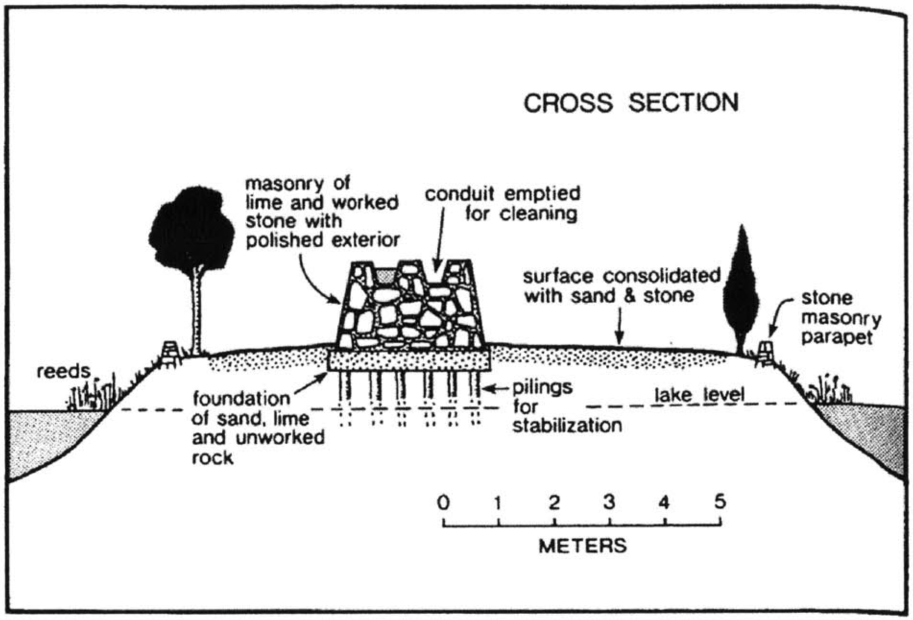

Fig. 13. 1465 Masonry Aqueduct (after Bribiesca Castrejón, 1958).

were built.[64] In conjunction with these improvements, the increase in the mass of the artificial islets speaks to one thing: durability. These advancements in construction were more than likely defensive measures taken to protect the aqueduct from future floods, and by extension, to provide the city with a stable flow of water during times of disaster when the city needed it most.[65]

Archaeological studies have been beneficial for understanding hydraulic structures. Today, the Number Two line of Mexico City's metro system runs above the pre-Columbian causeway of Iztapalapa (Fig. 14). The causeway was built under the rule of Itzcóatl in ca. 1499. In the form of tribute labor, demands were placed on the towns of Xochimilco, Azcapotzalco, and Coyoacán to construct a causeway from Tenochtitlan to Xochimilco.[66] But before the tracks

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64 *Ibid.*

65 At least three other aqueducts are known to have existed. See Palerm, *Obras hidráulicas prehispánicas en el sistema lacustre del Valle de México*, 240-242.

66 González Aparicio, *Plano reconstructivo de la region de Tenochtitlan*, 45.

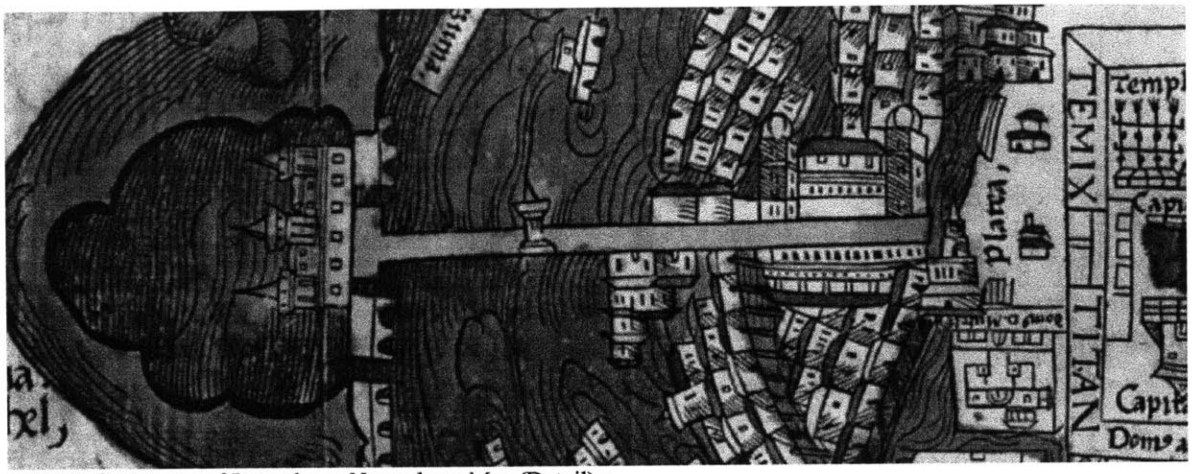

Fig. 14. Causeway of Iztapalapa, *Nuremberg Map* (Detail)

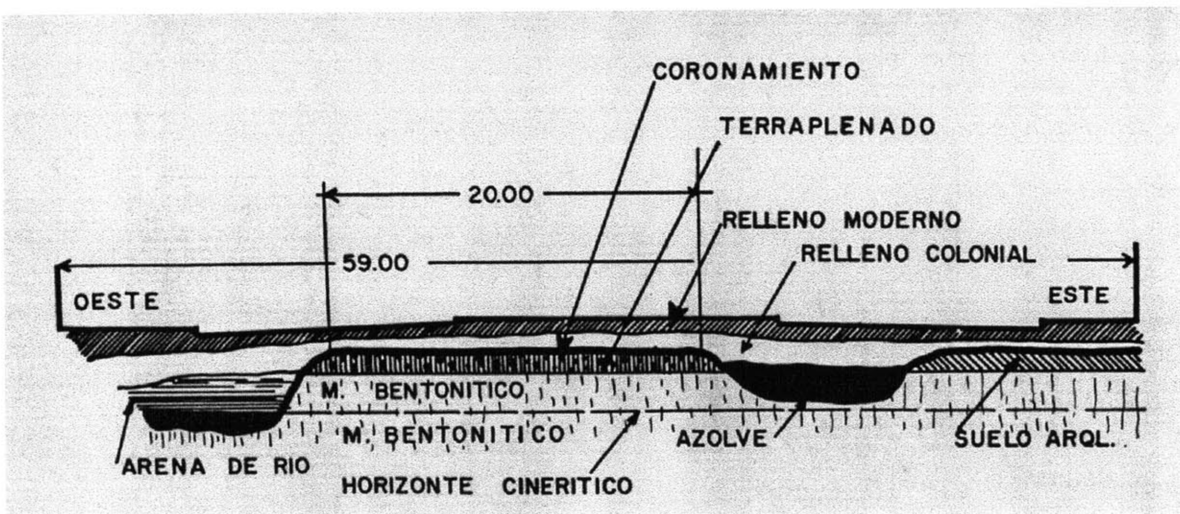

Fig. 15. Cross-Section of the Causeway of Iztapalapa.

could be laid, the terrain needed to be prepared to carry the weight of trains. As part of the excavation for building the roadbed, the causeway was fortunately exposed. In doing so, archaeological studies were undertaken from which a cross-sectional drawing was made (Fig. 15). Francisco González Rul and Federico Mooser noted that the causeway had a width between 15 and 20 meters, and that during their dig they were unable to locate a single floodgate.[67] The *calzada's* width and its (apparent) lack of openings confirm the idea that causeways with a north-

[67] González Rul and Mooser, "La calzada de Iztapalapa," 115-116.

south orientation doubled as dikes. The archaeologists also noted that the causeway had an elevation of 1.30 meters (slightly over 4 feet) above the old lake level. Perhaps even more significantly, they discovered two canals, one on each side of the causeway. Lake and river sediment was found in each channel, but the archaeologists did not offer a theory as to why the canals were constructed. The total width of the causeway, including its lateral canals, was estimated between 40 and 45 meters and having a length of 14,400 meters.[68]

Although not evident from the *Nuremberg Map*, a second island existed nearby. Tlatelolco was an independent city-state until conquered by the Aztec in 1473.[69] Prior to the defeat of the Tlatelolcans, they and the Aztec established fishing boundaries to avoid confrontations.[70] Negotiations can also be seen in the shared responsibility over the hydraulic network. Prior to Tlatelolco coming under the control of Tenochtitlan, both polities had jurisdiction over portions of the network. For example, the former supervised the causeways of Tepeyac, Tenayuca, and Nonoalco, while the latter administered those of Tacuba, Chapultepec, and Iztapalapa.[71]

Not all hydrographic projects in the pre-Columbian period proved to be wise. In addition to the dike of Nezahualcóyotl and its negative environmental implications for Lake Texcoco, another example deserves mention. During the reign of Ahuízotl, lake levels began to decline, which would have had a disastrous effect on *chinampa* agriculture. To maintain desired water levels, a plan was devised to distribute water into the southern lakes from Coyoacán and

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[68] Francisco González Rul and Federico Mooser, "La calzada de Iztapalapa," *Anales del Instituto Nacional de Antropología e Historia* 14, no. 43 (1961), 116.

[69] Lombardo de Ruiz, "El desarrollo urbano de México-Tenochtitlan," 134.

[70] *Ibid.*, 132-134.

[71] Carballal Staedtler and Hernández, "Hydraulic Features of the Mexico-Texcoco Lakes during the Postclassic Period," 166. The *calzada* Tepeyac was completed in 1429. The Nonoalco causeway is dated to the early fourteenth century. The *calzada* of Iztapalapa was already in existence by the time Azcapotzalco fell in about 1432. The ruler of Texcoco supervised the construction of the causeway of Tacuba and its branch to Chapultepec in 1466.

Churubusco via a new aqueduct (ca. 1499).[72] However, with no way to adequately regulate the incoming flow of water, the decision proved catastrophic. Tenochtitlan flooded.[73]

Chinampas and Chinampa Construction

The map known as the *Plano en papel maguey* (ca. 1543 and housed in Mexico's Instituto Nacional de Antropología e Historia), although deteriorated, also allows insight into the relationship between the lakes and the city (Fig. 16).[74] In particular, it sheds light on *chinampas*, *chinampa* technology, and how these were employed not only for agricultural production, but were also the basis for urban growth. It is executed on paper made from the *maguey* plant, having a dark sepia tone and highlighted with vegetable coloring, illustrating the map's alternating pattern of *chinampas* and canals. Toussaint and Fernández have argued that *Plano en papel maguey* depicts a northern region of the island, east of Tlatelolco (Fig. 17). The map is a cadastral survey, of more than 400 residential sites, each having a small house, and adjoined by six or seven *chinampas* (Fig. 18).[75] The name glyphs for each *chinampa* site suggest that the map alludes to the type of property register kept by community officials (*calpuleque*) in pre-Hispanic times.[76]

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[72] Lombardo de Ruiz, "El desarrollo urbano de México-Tenochtitlan," 135.
[73] *Ibid.*, and García Quintana and Romero Galván, *México Tenochtitlan y su problemática lacustre*, 88-90.
[74] The map is also referred to as *Plano parcial de la Ciudad de México*.
[75] Calnek has argued that the map represents a location west of the church of Santa María la Redonda. See Edward, E. Calnek, "The Localization of the Sixteenth Century Map Called the Maguey Plan," *American Antiquity* 38, no. 2 (Apr., 1973), 190.
[76] *Ibid.*

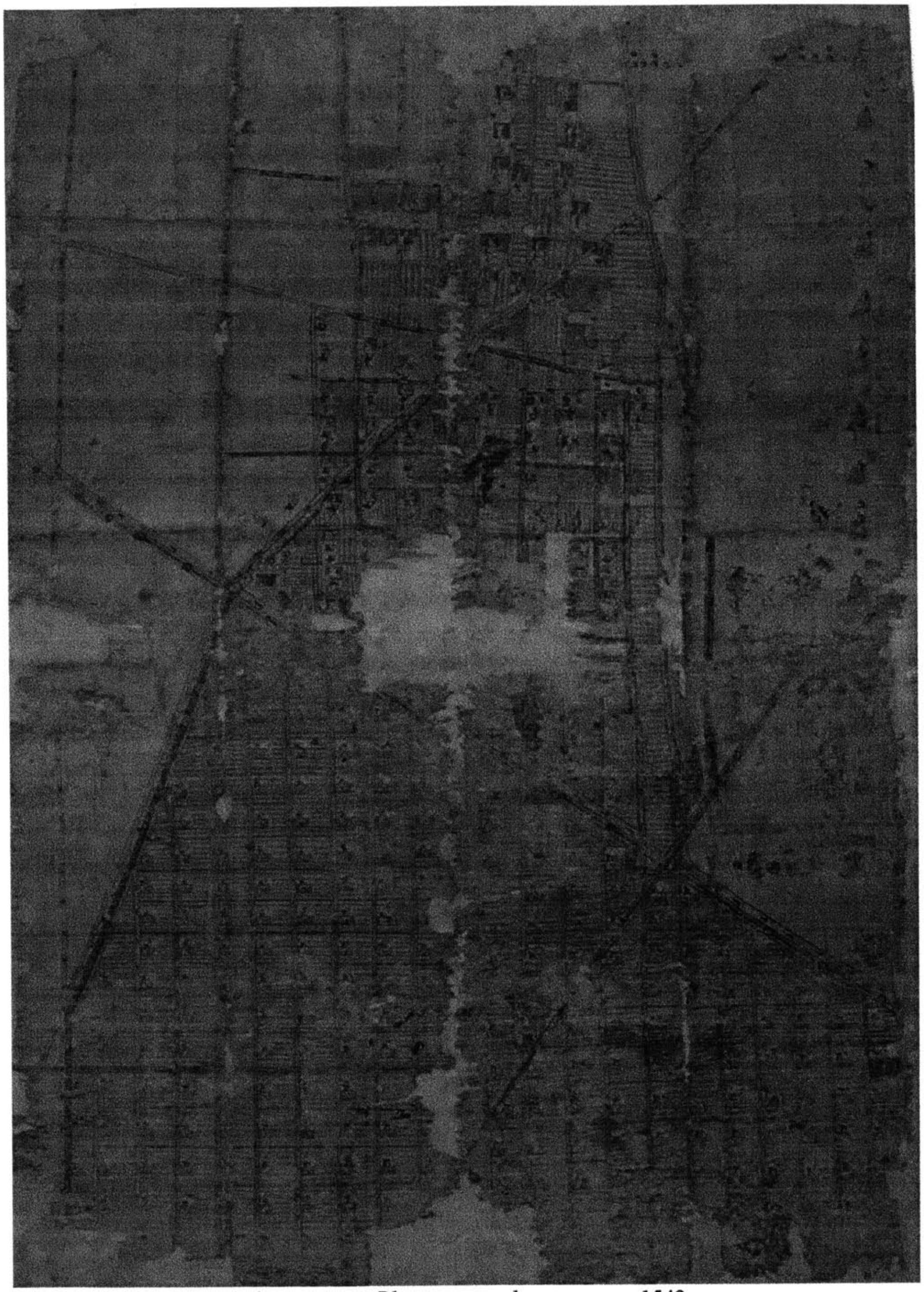

Fig. 16. Anonymous, *Plano en papel maguey*, ca. 1543.
Source: Instituto Nacional de Antropología e Historia.

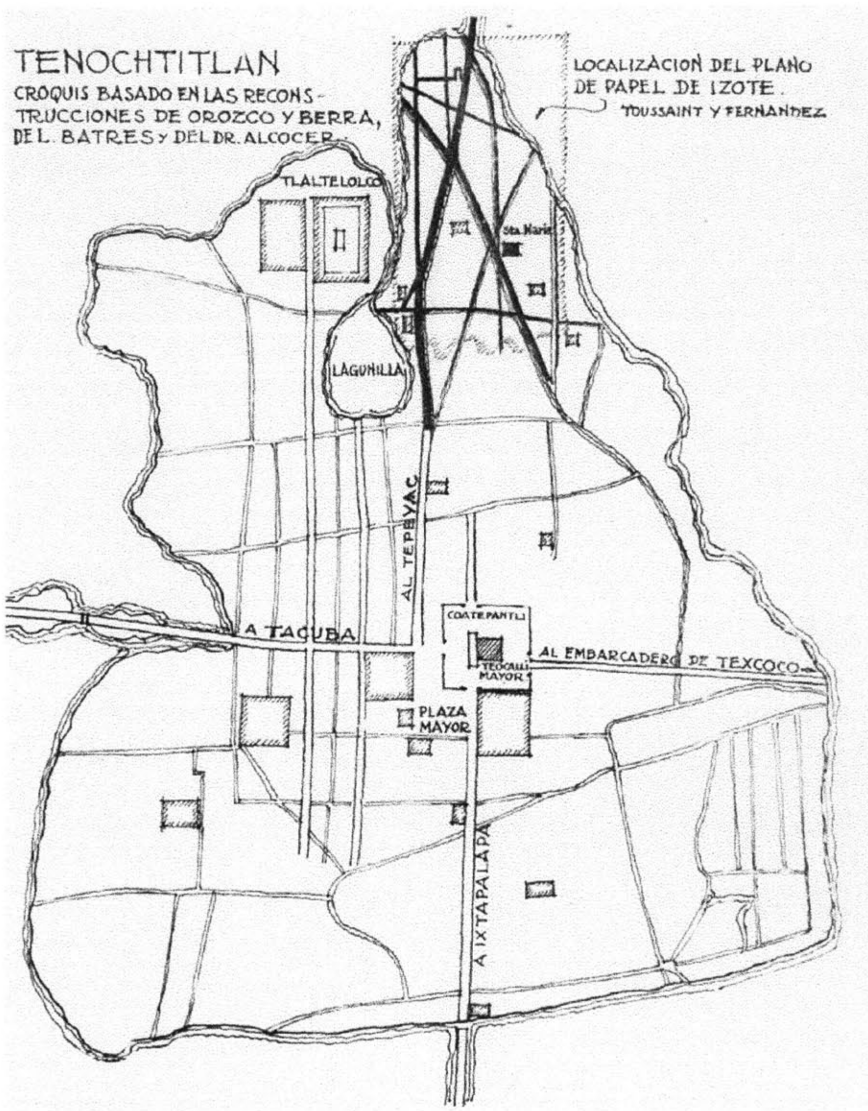

Fig. 17. Manuel Toussaint and Justino Fernández,
Map of Tenochtitlan showing region depicted in *Plano en papel maguey.*

Fig. 18. *Chinampas*, *Plano en papel maguey* (Detail).

From a detail of the *Plano en papel maguey*, we can deduce that *chinampas* were long and narrow raised fields.[77] The dimensions of *chinampas* varied depending on their use and location. In some instances they ranged from 3 to 5 meters in width and 60 to 90 meters in length.[78] In other cases they were narrower, between 2 and 4 meters, and shorter in span, between 20 and 40 meters.[79] Their method of construction is important. *Chinampas* were made by "alternating layers of lake mud" and "mats of decaying vegetation."[80] A key characteristic of the *chinampa* was its adjacent canal (Fig 19).[81] This spatial arrangement produced an alternating

[77] The word *chinampa* derives from the Classical Nahuatl word *chinamitl*, meaning "reed boundary or hedge, or fence with sticks or intertwined reeds." Refer to Saúl Alcántara Onofre, "The Chinampas of the Valley of Mexico," in *Gardens and Cultural Change: A Pan-American Perspective*, ed. Michel Conan and Jeffrey Quilter, (Washington D. C.: Dumbarton Oaks Research Library and Collection; Cambridge: Distributed by Harvard University Press, 2007), 9.

[78] *Ibid.*, 19.

[79] Jeffrey R. Parsons, "Political Implications of Prehispanic Chinampa Agriculture in the Valley of Mexico," in *Land and Politics in the Valley of Mexico: A Two-Thousand Year Perspective*, ed. H. R. Harvey (Albuquerque: University of New Mexico Press, 1991), 21.

[80] Edward E. Calnek, "Settlement Pattern and Chinampa Agriculture at Tenochtitlan," *American Antiquity* 13, no. 1 (Jan., 1972), 105.

[81] Droughts also plagued the island. Yet the presence of water in canals lessened the effects of drought and also frost. Fox, "Man-Water Relationships in Metropolitan Mexico," 523; and Thomas M. Whitmore and B. L. Turner II,

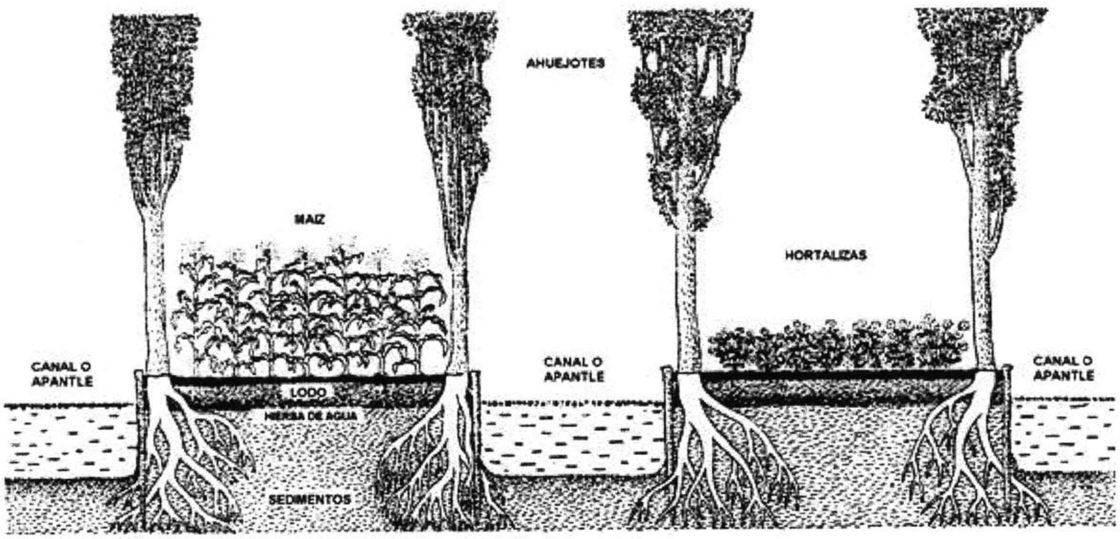

Fig. 19. Cross-Section of *Chinampa-Canal Alternating Pattern*.

pattern of raised bed and canal, creating "an exceptionally rigorous approach to city planning throughout the major periods of urban growth.[82] Separated by canals, these artificial platforms were elevated between 50 and 150 centimeters (19.5 and 59 inches) above the level of the lakes.[83] When these raised fields had reached a height of 25 centimeters above water levels, they were lined with willow trees (*ahuejotes*) to shore up their edges, which were planted at a distance of 4 to 5 meters apart.[84] Cypress trees were also used.

Not all *chinampas* were identical. The residential homes in the *Plano en papel maguey* occupy an area no more than twenty-five percent of the *chinampas*, while those nearest the island covered up to fifty percent of their respective man-made platforms.[85] In addition to this difference, there are others. Homes in the former are always situated on the western side of the

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"Landscapes of Cultivation in Mesoamerica on the Eve of the Conquest," *Annals of the Association of American Geographers* 82, no. 3, The Americas before and after 1492: Current Geographical Research (Sep., 1992), 409.

[82] Calnek, "Settlement Pattern and Chinampa Agriculture at Tenochtitlan," 109-111.

[83] Philip L. Crossley, "Just Beyond the Eye: Floating Gardens in Aztec Mexico," *Historical Geography* 32 (2004), 112.

[84] Alcántara Onofre, "The Chinampas of the Valley of Mexico," 20,

[85] Calnek, "The Localization of the Sixteenth Century Map Called the Maguey Plan," 192.

reclaimed islets regardless of whether their position adjoined a canal or street.[86] At the pre-Columbian capital, residential platforms were organized into "mirror-image pattern," where platforms flanked both sides of a canal.[87]

Residential *chinampas*, nearest the city, rarely exceeded 600 square meters, save for palatial compounds.[88] The typical residential unit in Tenochtitlan's urban zone was an enclosed compound usually occupied by a "bilateral joint family, which included from 2 to 6 closely related nuclear families" having their individual homes.[89] The compound enclosure consisted of perishable and non-perishable materials, such as stone, adode, cornstalks, or rushes.[90] At the very minimum compounds were occupied by 2-3 people, having a maximum of 25-30, but with an average of 10-15; each family lived in a 1-2 room structure or inhabiting a floor of a two-story structure.[91] Small vegetable plots were a common feature of residential *chinampas*. Based on contemporary yields of *chinampa* farming and dietary needs, the pre-Columbian fields would have only provided enough foodstuffs to supplement, not sustain, caloric intake.[92]

In the southeastern sector of the island city, the *chinampa* was constructed along substantially different guidelines. For instance, they were much larger than their urban counterparts, ranging between 4,000 and 5,000 square meters and yet their residential compounds were smaller.[93] In addition, the alternating pattern of *chinampa* and canal, important to the city's formal organization in its northern region as depicted in the *Plano en papel maguey*, was completely abandoned. Each raised field in the south now had a canal on three, and sometimes,

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86 *Ibid.*
87 *Ibid.*
88 Calnek, "Settlement Pattern and Chinampa Agriculture at Tenochtitlan," 111.
89 *Ibid.*
90 *Ibid.*
91 *Ibid.*
92 *Ibid.*, 111-112.
93 *Ibid.*, 112.

four sides.[94] Primarily built in the fresh-water lakes of Xochimilco and Chalco—representing the southern portion of the lacustrine environment—the *chinampas* were constructed exclusively for agricultural reasons.

Their design maximized yields by providing year-round irrigation.[95] This occurred in two ways: first, through seepage at the root zone, which allowed for continuous moisture even during the dry season, and second, by "harvesting" the lake mud, high in organically rich nutrients, to apply it to the *chinampas*.[96] Cultivation not only occurred on the surface area of these raised beds, but in some instances, on their sides as well.[97] Aquatic mud, decaying vegetation, household waste, bat dung, and human excrement were used for fertilization.[98] It is estimated that more than 9,000 hectares (22,230 acres) were reclaimed from only the southern portion of the lakes and that this region alone produced enough food—tomatoes, beans, squash, maize, amaranth, and chili peppers, among others—to feed upwards of 100,000 people, of which more than half went to support urban life.[99] Based on archaeological evidence, Pedro Armillas suggests that the peak of the *chinampa* construction for agricultural production began around

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94 *Ibid.*

95 Pedro Armillas, "Gardens on Swamps," *Science* 174, no. 4010 (Nov. 12, 1971), 653-654.

96 Armillas, "Gardens on Swamps," 653-654; William M. Denevan, "Aboriginal Drainage-Field Cultivation in the Americas," *Science* 169, no. 3946 (Aug. 14, 1970), 647; and Andrew Sluyter, "Intensive Wetland Agriculture in Mesoamerica: Space, Time, and Form," *Annals of the Association of American Geographers* 84, no. 4 (Dec., 1994), 557-558.

97 Alcántara Onofre, "The Chinampas of the Valley of Mexico," 20.

98 Whitmore and Turner, "Landscapes of Cultivation in Mesoamerica on the Eve of the Conquest," 409; and Parsons, "Political Implications of Prehispanic Chinampa Agriculture in the Valley of Mexico," 21.

99 Armillas, "Gardens on Swamps," 660. On the other hand, Parson and Brumfiel, respectively, believe this figure to be in fact greater, closer to 10,000 hectares or 24,700 acres. Parsons, "Political Implications of Prehispanic Chinampa Agriculture in the Valley of Mexico," 40; and Elizabeth M. Brumfiel, "Agricultural Development and Class Stratification in the Southern Valley of Mexico," in *Land and Politics in the Valley of Mexico: A Two-Thousand Year Perspective*, ed. H. R. Harvey (Albuquerque: University of New Mexico Press, 1991), 43.

1400 and was continued into the colonial period to about 1600, representing a "planned enterprise."[100] He writes:

> The comprehensive view of traces of old chinampas afforded by the aerial photomaps incontestably shows that the layout of plots was regulated by some overall scheme. Generally, the chinampas that can be dated to Aztec times were built in sets that were arrayed within rectangular blocks delimited by the grid of service canals. Distances between the limiting canals are not uniform everywhere, but they fit in patterns that indicate some sort of modular system in the allotment of space.[101]

Chinampa development did not happen without significant human intervention. Deborah L. Nichols and Charles D. Frederick have noted in "Irrigation Canals and Chinampas: Recent Research in the Northern Basin of Mexico" that two major developments in hydraulic agriculture took place in the Postclassic period in the northwestern section of the Basin of Mexico.[102] The first change is of importance to this study. In the fifteenth century, the nobility of Cuautitlán redirected the Cuautitlán River to prevent the flooding of their town, a hydraulic project that took seven years to complete.[103] Originally, the Cuautitlán River flowed into Lake Xaltocan, but in an effort to also increase the irrigation of *chinampa* fields at Lake Zumpango, the river was diverted northward.[104] The preferred method for redirecting rivers was to channel one into another. After excavating a canal over 6 kilometers in length, the Cuautitlán was made to flow into the Tepotzotlán River, which also required improvements (Fig. 20).[105] These included increasing its depth and width to accommodate the Cuautitlán's water, and reducing its sinuous length by 10 kilometers. Channeling the river northward had no negative impact on the amount of water that

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[100] Armillas, "Gardens on Swamps," 657-660. In a different example, Nichols and Frederick note that *chinampa* agricultural production continued into the colonial period at Xaltocan, and that in general, it may have been a continuous practice until the mid-seventeenth century. See Deborah L. Nichols and Charles D. Frederick, "Irrigation Canals and Chinampas," in *Economic Aspects of Water Management in the pre-Hispanic New World*, ed. Vernon L. Scarborough and Barry L. Isaac (Greenwich: JAI Press, 1993), 141-142.

[101] Armillas, "Gardens on Swamps," 660.

[102] Nichols and Frederick, "Irrigation Canals and Chinampas," 135.

[103] *Ibid.* See also Doolittle, *Prehistoric Mexico: The Sequence of Technological Change*, 117.

[104] Doolittle, *Canal Irrigation in Prehistoric Mexico*, 117.

[105] *Ibid.*

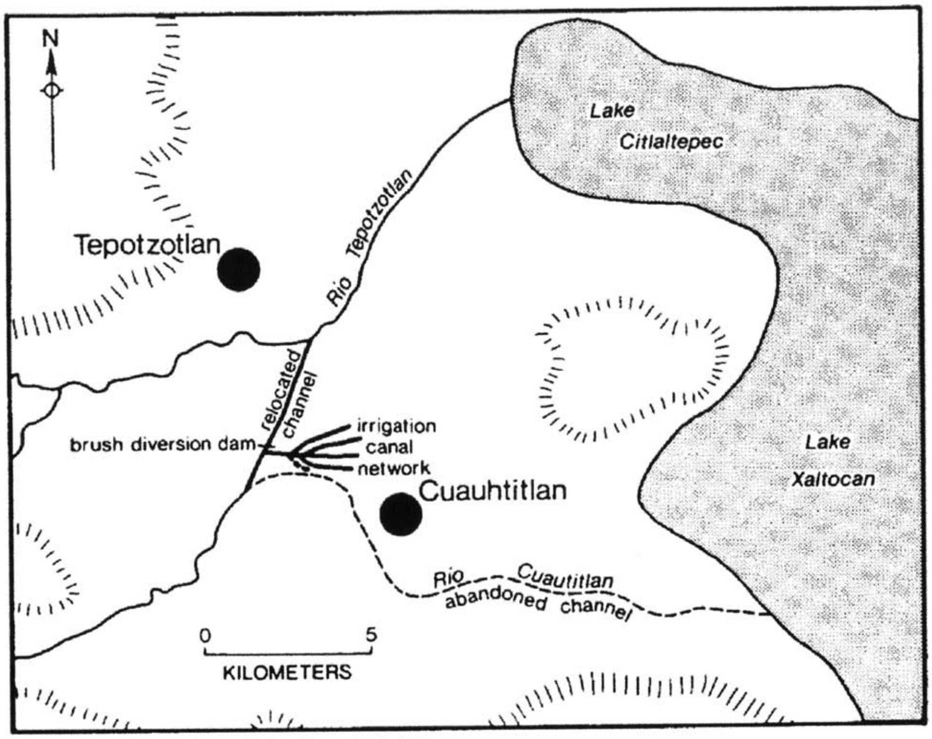

Fig. 20. Rechanneling of the Cuautitlán River.

flowed into the lacustrine environment, but its benefits to the *chinampa* fields have been identified.

Nichols and Frederick have also argued that economic motivations in conjunction with flood control underpinned the rechanneling of the Cuautitlán River. Rerouting the river made possible the irrigation of 8,000 to 10,000 hectares (between 19,760 and 24,700 acres), which "facilitated control of both labor and resources by concentrating population on the alluvial plain."[106] Cuautitlán, by extension, became one of the largest tributary areas under Aztec control and its importance to Tenochtitlan can be understood in the following quotation:[107]

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[106] Nichols and Frederick, "Irrigation Canals and Chinampas," 135.
[107] *Ibid.*

> Tenochtitlan had both greater need for the subsistence security that only a nearby, fully developed chinampa operation could provide; and the ability to mobilize sufficient human labor to effect the tremendous physical and administrative effort required to transform agriculturally useless swampland into highly productive garden plots.[108]

Chinampa construction in the Postclassic era developed in two phases.[109] In the first stage, peasant groups, organized into *calpullis*, constructed *chinampas* in a "piecemeal fashion."[110] In this older-lakebed community model, the *macehualtin*, or "free commoners" worked the land to provide tribute and labor to a local ruler while retaining community landholdings.[111] The second stage of *chinampa* building involved state intervention and management. Parson has noted that the Aztec called for large-scale development to create a stable and constant food supply for the pre-Columbian capital.[112] This latter phase of agriculture included a new organizational model. Instead of *calpullis* having control over these human-made islands, nobles, based in Tenochtitlan, were entrusted with their administration, holding them in "private, patrimonial estates."[113] This shift in jurisdictional control also included a change in the organization of labor. Instead of the *macehualtin* working *calpulli* land, a *mayeque*, or serf, worked the land for the nobles.[114] This difference in how labor was structured has recently come under re-examination. Brumfiel has stated that little difference existed between labor models.[115]

Aztec reliance on *chinampa* agriculture is undeniable. Yet maintaining a constant supply of food required hydraulic intervention. Equally important was the avoidance of flooding,

108 Parsons, "Political Implications of Prehispanic Chinampa Agriculture in the Valley of Mexico," 39.
109 Nichols and Frederick, "Irrigation Canals and Chinampas," 143.
110 *Ibid.* A *capulli* was a sub-organizational unit of the *altepetl* composed of a group of families living in a single location. See Gibson, *The Aztecs Under Spanish Rule*, 34.
111 Brumfiel, "Agricultural Development and Class Stratification in the Southern Valley of Mexico," 44.
112 Parsons, "Political Implications of Prehispanic Chinampa Agriculture in the Valley of Mexico," 34; Nichols and Frederick, "Irrigation Canals and Chinampas," 143; and Denevan, "Aboriginal Drainage-Field Cultivation in the Americas," 647.
113 Brumfiel, "Agricultural Development and Class Stratification in the Southern Valley of Mexico," 44.
114 *Ibid.*, 45.
115 *Ibid.*

disastrous to these raised fields. For the *chinampas* to produce year-round, water tables needed to be regulated. If the lake level were too low, seepage at the root level would not occur. If too high, plants would become waterlogged. In both cases, *chinampa* yields would drop—in turn, making it difficult to sustain the region, and more specifically, urban life at Tenochtitlan. Maintaining proper water levels over these large aquatic food production regions demanded a stable aquatic environment. Without it, *chinampa* fields would be at the mercy of the ebb and flow of the lakes in the best-case scenario, or at risk of being washed away by a flood. Neither would be to the benefit of the urban island dwellers. As a result, pre-Columbian hydraulics had a two-fold goal in mind: to protect Tenochtitlan from flooding on the one hand, and to protect the *chinampa* fields on the other. Both goals were critical to the survival of Tenochtitlan.

Salt and Urban Expansion

Understanding salinity differences between the lakes is important for comprehending Tenochtitlan's checkered expansion.[116] While Lake Mexico was principally a freshwater lake, it did contain some briny waters. As one drew closer to Lake Texcoco, for example, the salt levels of Lake Mexico increased, a condition that more than likely occurred through seepage via the dike and when its floodgates were opened, a common practice in the mornings.[117] (The reason for this practice is explained in Chapter 2.) In contrast, the salinity levels south of the city greatly diminished because of its proximity to the freshwater lakes of Xochimilco and Chalco. This difference in salt content created a condition where expansion southwards was more desirable.[118]

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116 Mier y Terán Rocha, *La primera traza de la ciudad de Mexico*, 95; and Lombardo de Ruiz, "El desarrollo urbano de México-Tenochtitlan," 137.
117 García Quintana and Romero Galván, *México Tenochtitlan y su problemática lacustre*, 103.
118 *Ibid.*, 61. They proposed that the first *chinampas* built on the south side of the island.

Indeed, observe how the island extends to the south and also the west in Fig. 17. The northern side of the city pales in comparison to its southern edge.[119]

In his reconstruction of Tenochtitlan and its environs, Luis González Aparicio posed a hypothesis about urban growth. When writing about the pre-Columbian dike of Ahuízotl (ca. 1499; named after the eighth Aztec ruler and known as San Lázaro in colonial times), he suggested that this hydraulic element was not intended to control flooding, but rather to further diminish the salinity levels of Lake Mexico.[120] (The dike is not depicted in the *Nuremberg Map*, but it hugged the island's eastern shoreline). Higher salinity levels were detrimental to *chinampa* food production. Too much salt causes ionic stress in plants, greatly reducing their ability to do photosynthesis, and eventually causing them to die.[121] Texcoco's salty waters would have dire consequences if they reached the *chinampa* beds of lakes Mexico, Xochimilco, and Chalco, where the city's food was produced.[122] In addition, González Aparicio also argued that the dike of Nezahualcóyotl was built for land reclamation purposes and for improving the water quality of the lake. [123] Both dikes, in his opinion, would improve the lake's fish stock, provide irrigation for mainland vegetable gardens and orchards, and increase the yield of *chinampas*. Yet not all salt was detrimental to *chinampa* agriculture. Nichols and Frederick have noted that the basin's northern lakes were saline, but *chinampa* agriculture continued, given that they were not

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119 Lombardo de Ruiz, "El desarrollo urbano de México-Tenochtitlan," 128.

120 González Aparicio, *Plano reconstructivo de la region de Tenochtitlan*, 34. The idea of improving the conditions of Lake Mexico by building the dike of Ahuízotl is also offered by García Quintana and Romero Galván, *México Tenochtitlan y su problemática lacustre*, 108. On the other hand, Carballal Staedtler and Hernández believe the dike was constructed to prevent flooding. See "Hydraulic Features of the Mexico-Texcoco Lakes during the Postclassic Period," 168.

121 http://www.sebiology.org/publications/Bulletin/July05/salinity.html. Accessed 30 July 2013.

122 Lombardo de Ruiz, "El desarrollo urbano de México-Tenochtitlan," 131.

123 González Aparicio, *Plano reconstructivo de la region de Tenochtitlan*, 34-38.

saturated with salts.[124] This perspective coincides with Palerm's position that *chinampas* could be found in all the lakes regardless of their saline content.[125]

The relationship between salt and urban growth demands analysis. When the Aztec founded Tenochtitlan, the island measured approximately 180 hectares or 444.6 acres.[126] Although it at first seemed a large plot of land, the pre-Columbians would soon outgrow their site. Besides lacking potable water and being vulnerable to flooding, the island site was also limited in one other respect: the lack of land for expansion. With a tried-and-tested method for reclaiming land from the lakes in the form of *chinampas*, the Aztec began expanding the city beyond the island's original boundaries.[127] By the time of Spanish arrival in 1519, Tenochtitlan, according to Calnek, covered an area between 12 and 15 square kilometers.[128] Converting García Lascurain's figure of 444.6 acres, the island measured 1.79 square kilometers. The difference between these figures lies in the range of 10.21 and 13.21 square kilometers. Thus, they multiplied the size of the island to between 5.7 and 7.3 times its original size in less than two hundred years.[129] The Aztecs' ability to reclaim land from the lakes for urban growth is simply astonishing!

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[124] Nichols and Frederick, "Irrigation Canals and Chinampas," 136.

[125] Palerm, *Obras hidráulicas prehispánicas*, 18-19.

[126] García Lascurain, *La ciudad de México-Tenochtitlán*, 47. She states the island was approximately 180 hectares.

[127] Lombardo de Ruiz, "El desarrollo urbano de México-Tenochtitlan," 127.

[128] Calnek, "Settlement Pattern and Chinampa Agriculture at Tenochtitlan," 105.

[129] These figures are not universally accepted. A more conservative estimate is obtained when substituting Calnek's figures with the 7.5 square kilometers suggested by Toussaint, Gómez de Orozco, and Fernández. See *Planos de la Ciudad de México*, 72. The difference between this new number and García Lascurain's 1.79 square kilometers is 5.71 square kilometers. It is still a substantial expansion of the island's surface area. Regardless of whether one figure or another is correct, there is no question that the Aztec increased the size of the island by building *chinampas*. Not all this area can be considered solely as reclaimed land; as the Aztec grew their city they incorporated nearby islands such as Tlatelolco. See García Quintana and Romero Galván, *México Tenochtitlan y su problemática lacustre*, 62. The Aztec were not the only group in the basin to employ *chinampas* for urban growth. Churubusco, Culhuacan, Xochimilco, Cuitláhuac, Míxquic, Tláhuac, Tetelco, and Tezompa are just a sample of settlements that *chinampas* made possible. See González Aparicio, *Plano reconstructivo de la region de Tenochtitlan*, 86; and García Quintana and Romero Galván, *México Tenochtitlan y su problemática lacustre*, 39. These settlements were solely located in the freshwater lakes. Iztapalapa was a hybrid city, resting on water and the

Conclusion

Without a doubt, the management of water was force in Tenochtitlan's urban fabric. The *Nuremberg Map*, folio 2r of the *Codex Mendoza*, and *Plano en papel maguey* demonstrate the Aztec capital's aquatic condition. Although these three images differ in how they depict the city and its relationship to the lakes, they nonetheless impress upon the viewer how water was incorporated into Tenochtitlan's architectural fabric. These historical images also demonstrate the Aztec method of water management. For the Aztec, flood control was an important issue. Yet it was not conceived of as an isolated concern. Instead, it was one worrisome aspect of a much larger approach to water management. The pre-Columbian method for managing water centered on constructing hydraulic elements—causeways, dikes, and floodgates, among others—that would regulate the ebb and flow of the lakes, thus creating a stable aquatic environment. A controlled water table not only kept catastrophic inundation at bay, but it also benefited *chinampa* agricultural production, which in turn went to support urban life at Tenochtitlan. A regulated lake environment allowed the Aztec to overcome one of the island's shortcomings: the lack of land for urban growth. Employing the same technology used in raised field agriculture, the Aztec transformed water into reclaimed land. Thus, we can begin to comprehend how the pre-Columbians constructed a framework to manage water that was multi-layered, providing a range of benefits. Importantly, these historical images imply that the risk of catastrophic inundation is part of everyday life at Tenochtitlan. Finally, the study of Aztec water management and its relationship to Tenochtitlan is important for understanding just how different the Spanish approach to water management and urban form was after they occupied the island site.

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mainland. Consult González Aparicio, *Plano reconstructivo de la region de Tenochtitlan*, 90. By comparison, no significant city was constructed in the saltwater lakes, save Texcoco. Fox, "Man-Water Relationships in Metropolitan Mexico," 526.

Chapter 2:

Indigenous Commentary on Sixteenth-Century Mexico City

> The cosmographer of the Spanish Emperor Carlos V, Alonso de Santa Cruz, salutes your Majesty. The map offered here permits a close look at the city of Tenuxititan [Tenochtitlan] until now seen by but few [Europeans], by means of a service which thus, so to speak, may be said to offer a good augury for the future. It is a pleasure to see what all agree is the will of Your Majesty, to preserve this city; and in a picture of the conquered city showing spatial arrangements, waterways, and environs there is an evidence of Your Majesty's clemency.[1]
>
> Dedicatory to Charles V from the Royal Cosmographer Alonso de Santa Cruz
> (English translation of its Latin original)

Located today in the University Library of Uppsala in Sweden, the *Uppsala Map* is a mid-sixteenth-century map of viceregal Mexico City (Fig. 1). It comprises a double-sheet parchment, measuring 114 x 78 cm (24 x 31 inches) and is oriented with west towards the top.[2] The map is a cartographic description of the Basin of Mexico, identifying Mexico City and its lacustrine environment, mountains, forests, town, and roads. The countryside is vibrant with color and full of people performing an array of activities indicative of sixteenth-century life. The description of the countryside is one that any historian, cultural anthropologist, or ethnohistorian, among many others, would admire for its visual commentary on the basin's social life. In marked contrast, the city is void of any color save for a grey wash. In the lower right-hand corner of the map, we find the royal cosmographer Alonso de Santa Cruz' dedicatory in Latin to the Spanish

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[1] A. B. Elsasser, *The Alonso de Santa Cruz Map of Mexico City and Environs, Dating from 1550* (Berkeley, CA, 1974), 2-3. For an online high-resolution image Uppsala Map, consult the Uppsala University Library webpage, www.ub.uu.se/en/Collections/Map-collections/Section-for-Maps-and-Pictures-map-collection/Map-of-Mexico/. This transcription coincides with the one offered by J. Svennung, which is located in Sigvald Linné, *El Valle y la Ciudad de México en 1550: relación histórica fundada sobre un mapa geográfico, que se conserva en la Biblioteca de la Universidad de Uppsala, Suecia*, 2nd ed. (Mexico City, 1988), 176-177.

[2] Linné *El Valle y la Ciudad de México*, 163.

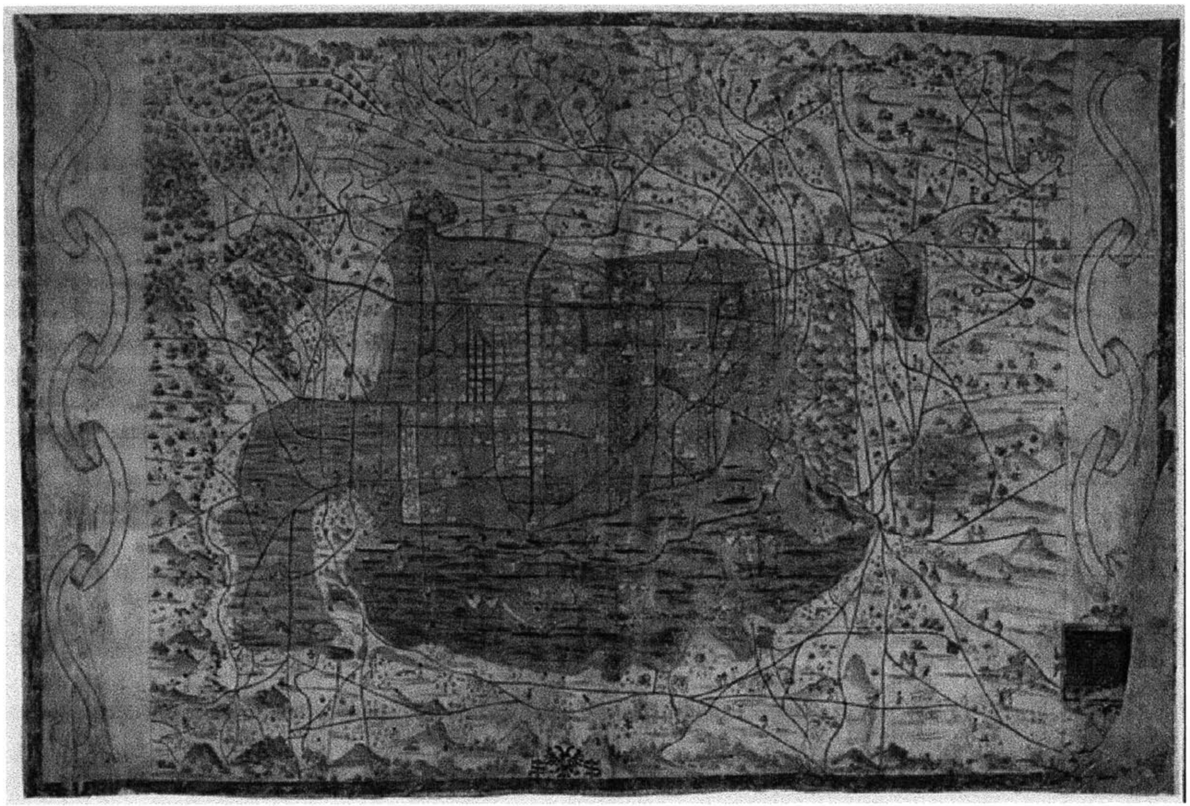


Fig. 1. Anonymous, *Uppsala Map*, ca. 1550, watercolor on parchment, 44 7/8 in. x 29 1/2 in. (114 x 75 cm). Uppsala University Library, Uppsala. Photograph provided by the Uppsala University Library.

monarch Charles V. Partially defaced, the dedicatory describes the spatial organization of Mexico City (referred to as Tenochtitlan) and for this reason alone, the map was believed to be the work of the royal cosmographer.[3] Yet the nearly 200 Indian toponyms, sometimes Europeanized, have required scholars to reconsider the map's author as indigenous or *tlacuilo*, the Classical Nahuatl word for painter/scribe, or in this case, mapmaker.[4] Likewise, the map's glosses are a combination of indigenous toponyms describing geographical features that can be seen

[3] For an understanding of the various hypotheses offered as to the map's provenance see Linné (*ibid.*, 195-199).

[4] Miguel León Portilla and Carmen Aguilera, *Mapa de México Tenochtitlan y sus contornos hacia 1550* (Mexico City: Celanese Mexicana, S.A., 1986), 49.

alongside European script highlighting towns and institutions.[5] The map is framed on all sides by a decorative border with a blue vine-like garland. Sometime around 1550, an anonymous Indian cartographer made the *Uppsala Map*.

In this chapter, I devote my attention to the study of how a single narrative figure in the *Uppsala Map* frames our understanding of sixteenth-century Mexico City. Hitherto, no scholar has mentioned this figure, let alone examined it. The absence of a study on this figure highlights an intellectual lacuna in our understanding of how the *tlacuilo* framed his commentary on Mexico City. The importance of the narrative figure cannot be underscored enough. It breaks in a definitive manner from all other figures on the map respective its location, posture, activity, optic concern. Simply put, he is the only figure in an otherwise uninhabited island. In my analysis of this figure, I argue that his corporal expressions, especially the gestures of his arms and hands presents the city for examination. The map identifies the great urban transformation the city underwent from its pre-Columbian form (a subject studied in Chapter 1) to becoming the seat of Spanish authority in the New World. Through an analysis of the island settlement, I identify the spatial, material, aesthetic character of the Spanish city to offer a new interpretation on the city's urban character. Not only is this interpretation based on a formal analysis of the *Uppsala Map*, but it is also substantiated by a study of municipal decrees known as the *actas de cabildo* (city council decrees). In my examination of these municipal decrees, I locate an anxiety on the part of the city council respective the city's overall architectural character. Such an anxiety begs for reexamination of the scholarship describing the city's urban plan. In my description of this anxiety, I bring into the discussion key philosophical tenets about the spatial organization of Spanish cities to identify how they were situated into a binary relationship of *policia*—the virtue

[5] Susan Toby Evans. "The Aztec Palace under Spanish Rule: Disk Motifs in the Mapa de México de 1550 (Uppsala Map or Mapa de Santa Cruz)," in *The Postclassic to Spanish-Era Transition in Mesoamerica: Archaeological Perspectives*, ed. Susan Kepecs and Rani T. Alexander (Albuquerque: University of New Mexico Press, 2005), 21.

of living a Christian way of life within spatial regularity—and how it stood in marked contrast to *vivir alarabe*—non-Christians living in irregular settlement patterns—to describe the so-called inherent qualities of Spaniards and Moors, respectively. I further describe how this bond was reconstituted in the New World to show how Indians substituted Moors. In my study of the *actas de cabildo,* I also emphasize an absence in decrees respective the hydraulic network depicted by the native mapmaker. By comparing these ordinances to those mandating the architectural character of the city, I show the former illustrates a disinterest on the part of the Spanish regarding the city's natural setting and the hydraulic structures that were to safeguard the city.

A Narrative Figure

The *Uppsala Map* describes the Basin of Mexico, specifically the region between Chimalhuacán Chalco to Jilotepec on one end, and from Teotihuacán to Santa Fe on the other.[6] The map identifies the Spanish capital, its lacustrine environment, and mainland towns. A network of roads, rivers, and streams can be seen crisscrossing the countryside. At first glance we can deduce that the map is organized into two parts: city and countryside. Their treatment regarding color and human activity suggests that they were conceived of differently, each attuned to a specific message about their character. For example, notice how the lakes and countryside are vibrant with color and human activity while the city is not. In the upper portion of the map near the decorative border, we find an Indian wearing animal skin with bow and arrow hunting a tan-colored buck in the western limits of the basin (Fig. 2). In a different scene, we find a Spaniard atop a horse, supervising two Indians on foot carrying goods on their backs (Fig. 3).

[6] Manuel Toussaint, "El plano de la Ciudad de Mexico atribuido a Alonso de Santa Cruz." In *11° Congreso internacional de historia de América, reunido en Buenos Aires en los días 5 a 14 de julio de 1937, conmemoración de IV centenario de la fundación de la ciudad de Buenos Aires* (Buenos Aires: Talleres de la S. A. Casa Jacobo Peuser, Ida, 1938), 3:570.

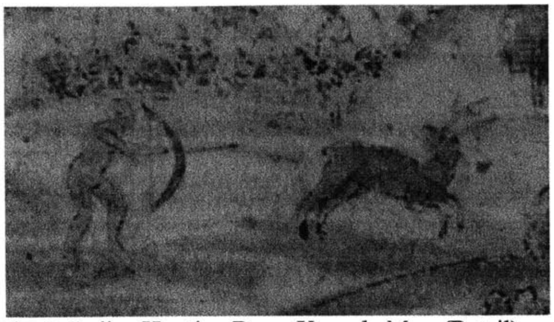


Fig. 2. Indian Hunting Deer, *Uppsala Map*, (Detail).

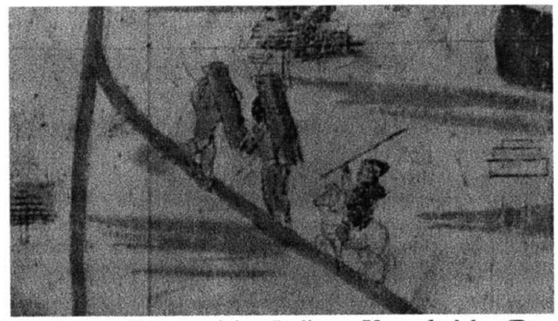
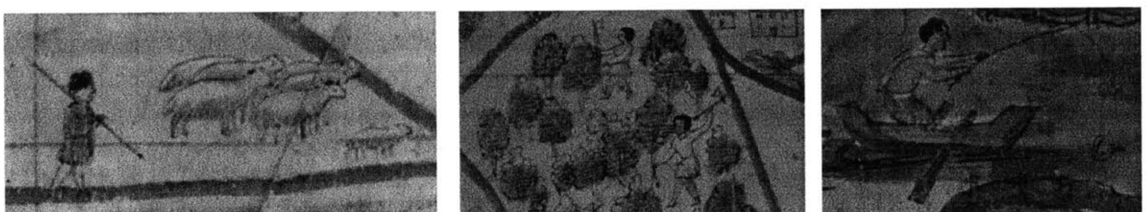


Fig. 3. Spaniard Supervising Indians, *Uppsala Map* (Detail).



Figs. 4-6. Sheepherding, Felling Trees, and Fishing, *Uppsala Map* (Details).

Without a doubt, the *Uppsala Map* is in part a portrait of social life, showing Spaniards and Indians in a variety of activities that also include herding sheep, woodcutting, and fishing (Figs. 4-6). Yet not all figures in the map are presented in a manner that is in character with mid-sixteenth-century life. In contrast to the Spaniard and Indians already mentioned, and the many more that are still visible, we find a singular figure depicted in a pose and activity of a very different nature and in a location where no others are to be found (Fig. 7). It impels us to ask the questions, What is this figure doing, and why? And what does the native mapmaker intend to convey by including it?

The figure is an adult Spanish male. In contrast, Indian figures are depicted with a thick mane of black hair, with exposed chest and legs, wearing traditional clothing. The narrative figure is of diminutive size in comparison to other nearby figures, but his stature is not an indicator of his importance. His significance is conveyed rather by location, pose, and activity. A quick glance at the island reveals that he is the only figure located on what is otherwise an

Fig. 7. Narrative Figure, *Uppsala Map* (Detail).

uninhabited settlement (Fig. 8). In noticeable difference to the vibrant colors employed to accentuate the lakes and countryside, the urban island appears in a muted grey wash. A closer inspection of this figure makes it known that he is also not in the Spanish city proper, the *traza*. Our narrative figure stands adjacent to the *traza*, which is illustrated by two streets in a sepia tone intersecting each other at ninety degrees. He is located in an interstitial zone between Lake Mexico in a long and narrow vertical section of island that corresponds to San Juan Moyotlan, one of the four pre-Columbian sectors of the city that remained after Aztec defeat. Standing on a secondary path of the same color as the *traza*, that extends from the city to the lake, with Indian homes in the background, this figure was imagined as part of the *Uppsala Map* from its inception. Notice that no color or marks bear witness to a change of mind beneath the reddish wash of the clothing or within the outline of his legs, torso, arms, or head. On the other hand, we can deduce that the waterway to his right was a later addition since its bluish hue overlaps his left hand. Besides the figure's unique location, his corporal expression is also of great significance. Our figure is shown with head slightly tilted downward and turned towards his right shoulder.

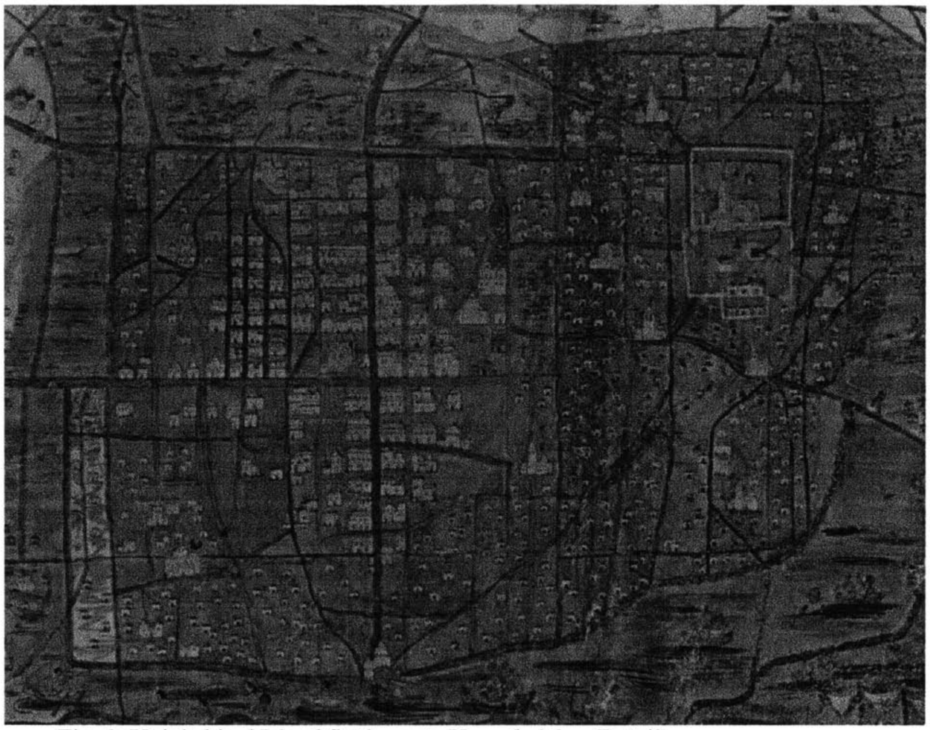


Fig. 8. Uninhabited Island Settlement, *Uppsala Map* (Detail).

His right leg is directed towards the picture plane, and his left, in the way of the city; hips are also rotated towards the settlement, and his shoulders are shown as almost parallel with the *traza.* His arms, bent at the elbows, extend towards the city. In his right land, barely visible, he holds what may be a palm, and his left is depicted as if either touching or holding the perimeter of the Spanish *traza.*[7] The narrative figure's corporal expression allows ideas to be expressed visually without begin spoken. Consider for example Quintilian's words:

[7] Clearly, the narrative figure is holding an object in this right hand. Even with a high-resolution image, it is difficult to discern what this object may be. I believe the figure is holding a palm, but this is only an educated guess. If this is the case, I will offer some analysis on the meaning of the palm. The palm is a unique visual artifact in the map. Unlike the Indians with axes felling trees, or Spaniard with sword supervising Indians, the palm conveys a message not associated with everyday sixteenth-century life. It is rooted in the Christian belief of a victory of the "faithful over the "unfaithful," and can also communicate the entry of Jesus into Jerusalem. It was not uncommon for Mexico City to be referred as a New World Jerusalem, as history of religion Jamie Lara has offered. See, Jaime Lara, *City, Temple, Stage: Eschatological Architecture and Liturgical Theatrics in New Spain* (Notre Dame: University of Notre Dame Press, 2004), 96-98. Lara further offers that we can understand transference as part of a "transportable geography," where the divinity of the latter could be instilled in the former (*ibid.*, 97). Within this biblical light, Mexico City can be understood as Jerusalem in the New World.

> As to the hands, without the aid of which all delivery would be deficient and weak, it can scarcely be told of what a variety of motions are susceptible, since they almost equal in expression the powers of language itself; for other parts of the body assist the speaker, but these, I may almost say, speak themselves. With our hands we ask, promise, call persons to us and send them away, threaten, supplicate, intimate dislike or fear; with our hands we signify joy, grief, doubt, acknowledgement, penitence, and indicate measure, quantity, number and time. Have not our hands the power of exciting, of restraining, of beseeching, of testifying approbation, admiration, and shame? Do they not, in pointing our places and persons, discharge the duty of adverbs and pronouns? So that amidst the great diversity of tongues pervading all nations and people, the language of the hands appears to be a language common to all men.[8]

In the late 1980s, art historian Moshe Barasch, who wrote a study on how the Italian painter Giotto di Bondone (1266/7-1337) employed hand gestures to convey meaning in many of his paintings, arguing that hands are the "organs of speech."[9] By extrapolating from Barash's research, we can begin to conceive how the *tlacuilo* ordered the narrative figure's bodily movements, especially his hands, to narrate the island settlement. Although the body is primarily directed towards the island settlement in its stance, his posture heightens the rotation of the head away from the city to highlight the figure's prolonged outward gaze. Not unlike the way a photograph captures a moment in time for eternity, the *tlacuilo* cemented the figure's posture and gaze precisely at the moment that emphasizes his look beyond the two-dimensional frame of the map. Keeping the figure's gaze in mind, we can see that all other figures in the *Uppsala Map* are depicted as lacking any interest in the world external to the map. This point highlights an important fact about the history of colonial Indian cartography of the sixteenth century. Until this moment, no Indian-made map contained a narrative figure like the one seen here, especially one that is interested in a world external of his own. More notably, with his outward gaze, he anticipates a viewer. Not to be confused with the *glance*, the figure's gaze solicits the presence of an external onlooker, and in doing so, also announces the presence of the mapmaker. Art historian Norman Bryson indicated the nature of this relationship in *Vision and Painting* when he

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[8] As quoted in Moshe Barasch, *Giotto and the Language of Gesture* (Cambridge: Cambridge University Press, 1987), 16.

[9] *Ibid.*

wrote "... the gaze of the painter arrests the flux of phenomena, contemplates the visual field from a vantage-point outside the mobility of duration, in an eternal moment of disclosed presence; while in the moment of viewing, the viewing subject unites the gaze...."[10] Uniting the gaze is not an act that can not be performed, but rather, as Marita Sturken and Lisa Cartwright have argued in the *Practices of Looking: An Introduction to Visual Culture*, it is a relationship enacted upon.[11]

A Depopulated City

The act of referencing a depopulated city against a populated and active countryside is a mechanism that serves to distinguish the former from the later. In European maps, coeval with the *Uppsala Map*, this visual narrative is usually situated around a figure that in form, activity, and location is isolated from all others, and equally significant, described as if contemplating, discussing, or mapping the city. Take for example what is believed to be the first early modern view of a city, *View of Florence with Chain* of c. 1510 after Francesco Rosselli (Fig. 9). The key narrative figure is the artist sitting in the lower right-hand corner of the map view (Fig. 10). With the aid of pad and pencil, he can be seen drawing attentively what in Renaissance architectural theory is one of the most significant aspects of any settlement: its city walls. The artist sits on a hill that has been identified as the place from which the view was drawn.[12] In other examples, as in many of the city views offered by Braun and Hogenberg in *Civitates orbis terrarum*, we find countless cities represented in which figures are depicted at a distance while

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10 Norman Bryson, *Vision and Painting: The Logic of the Gaze* (New Haven: Yale University Press, 1983), 94.
11 Marita Sturken and Lisa Cartwright, *Practices of Looking: An Introduction to Visual Culture* (Oxford: Oxford University Press, 2009), 94 and 103.
12 Friedman, "Fiorenza," 72.

Fig. 9. Francesco Roselli, *View of Florence with Chain*, ca. 1510.

observing, discussing, or contemplating the settlement. In these examples, the figures are depicted faraway from the respective settlements and in an elevated position, affording them an unobstructed view of the city. With respect to the *View of Florence with Chain*, Italian Renaissance art historian Lucia Nuti has described the sitting figure as "doubl[ing] the signature."[13] That is, while part of the picture plane, the artist stands outside of the visual narrative of everyday life to take note of Florence. Likewise, our colonial figure is part of the overall composition of the map, and not unlike Nuti's hypothesis offers, he also stands outside the everyday life of the city expressed in the *Uppsala Map*. This is where the similarities end between this European cartographic practice and its colonial manifestation. The figure in the *Uppsala Map* "doubles the signature" in a manner distinct from the city views by Rosselli or Braun and Hogenberg. In the *Uppsala Map*, the *tlacuilo* has forgone the distant and elevated positions that were key in these European views as the primary point of reflection, which he could have most easily offered from any of the nearby hills, such as Chapultepec, or any of the

[13] Lucia Nuti, "The Perspective Plan in the Sixteenth Century: The Invention of a Representational Language," *Art Bulletin* 76, no. 1 (Mar., 1994), 114.

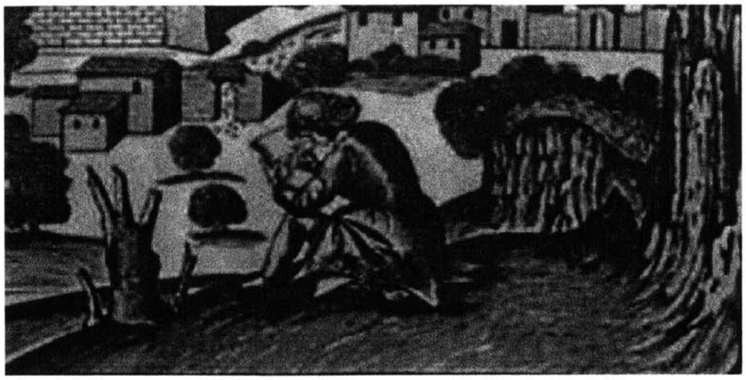

Fig. 10. Drawer on Hill, *View of Florence with Chain* (Detail).

mountains that comprise the Basin of Mexico. While the European views show their respective figures as isolated from the activities of the region, they are illustrated as having little or no interest in the world outside the two-dimensional frame of the image. Their attention is primarily directed towards the city, and perhaps this is one reason why their backs are often turned away from the viewer. The difference in pose, activity, and location are significant because they speak not only to the reinvention of this European visual practice, but also, and equally important, to the intentionality of the Indian mapmaker. To emphasize this point, the figure's presence is not whimsical or innocent, but rather is a conscious act of artistic will. The native mapmaker situated his figure firmly within the island settlement to present the viceregal capital.

Colonial Truth

In the lower right-hand corner, lying outside the pictorial field of the map but within the frame of the decorative border, we find the partially defaced dedicatory. Santa Cruz' dedicatory highlights important facts about the map and how we are to understand its graphic information. Consider for a start that the royal cosmographer dedicated the *Uppsala Map* to Charles V. This fact alone is an unusual aspect of the map's provenance. It is the first extant Indian-made map dedicated to a Spanish monarch. We can also study the dedicatory for what it says about the map's content. Santa Cruz thought the map to be truthful, offering documentary evidence as to the character of the city when writing, "the map offered here permits us a close look at the city of Tenuxtitan." Here, we must acknowledge the *tlacuilo's* skills—use of color and its application, line weight, proportion—and his understanding of city views and chorography. Without them, the native mapmaker could never have offered the kind of graphic information appreciated by Spanish cartographic sensibilities. Most notably, the royal cosmographer emphasized the capital's spatial and aquatic arrangement. Moreover, the connection between the map's documentary evidence and Spanish administrative goals were articulated when Santa Cruz wrote that the map provided a "good augury for the future." This relationship between map and administration was central for Spanish rule in the Americas. Historian of cartography David Buisseret has argued that Charles V "made extensive use of maps" in matters of "administration" in Spain.[14] In the Spanish New World, maps would support a similar agenda. The dedicatory thus highlights a unique moment in a trans-Atlantic dialogue between Spain and the New World: the royal cosmographer presented the *Uppsala Map* as a truthful depiction of the viceregal capital to Charles V for the future administration of the city. But how are we to understand the construction of truth in the *Uppsala Map*?

Italian Renaissance art historian David H. Friedman has offered in his study of *View of Florence with Chain,* that the isolated figure's presence in the view was understood as "taken from life."[15] That is, with the aid of pad, pencil, and draftsman, the author of the view made the claim that it was not copied, for example, from a print or another map, but rather, was an

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[14] Buisseret, *The Mapmaker's Quest*, 55.
[15] Friedman, "Fiorenza," 72.

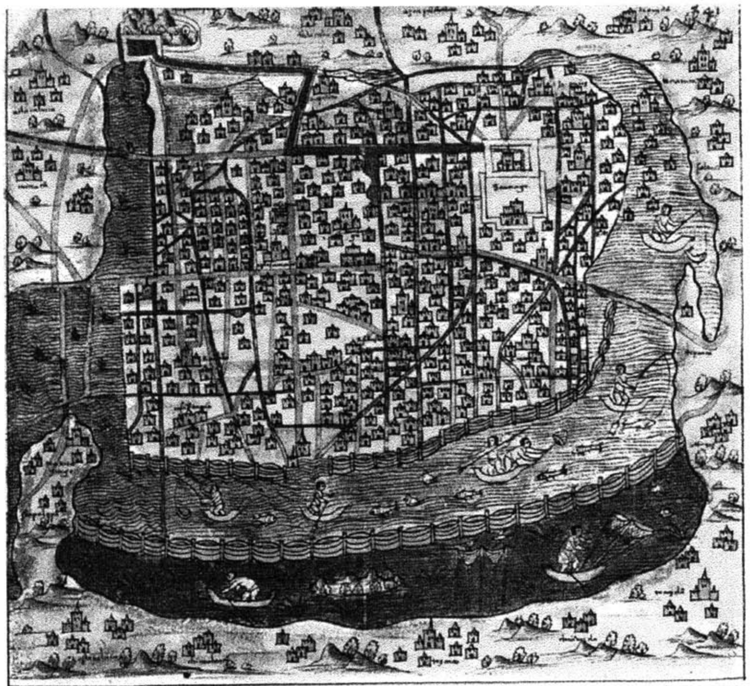

Fig. 11. Alonso de Santa Cruz, *Mapa de Santa Cruz*, ca. 1542.

accurate recording based upon empirical observation. Quite noticeably, our colonial figure lacks any of the items in the *View of Florence* that would have indicated the idea of "taken from life." But why then did Alonso de Santa Cruz conceive of the *Uppsala Map* as a truthful depiction of the viceregal capital when dedicating it to the Charles V? I argue that truth in the *Uppsala Map* is conveyed not by cartographic tools, but rather by the presence of the interlocutor.

To understand this point, let us examine Alonso de Santa Cruz' copy of the *Uppsala Map* published in *Islario general de todas las islas del mundo.*[16] The *Mapa de Santa Cruz* is smaller in size than the original (Fig. 11). Since it is primarily interested in depicting the island settlement, it foregoes a detailed description of the countryside In comparing the maps, we are

[16] Alonso de Santa Cruz, *Islario general de todas las islas del mundo*. 2 vols (Madrid: Imprenta del Patronato de huérfanos de intendencis é intervención militares, 1918).

Fig. 12. Missing Narrative Figure, *Mapa de Santa Cruz* (Detail).

able to discern similarities between the two. Both show the dikes of San Lázaro and Nezahualcóyotl protecting the eastern front of the city. Both emphasize Tlatelolco by portraying it proportionately larger than all other places on the island. The two maps also identify Indians in a number of activities of an aquatic nature, such as fishing, paddling a canoe, or capturing waterfowl. Save for some stylistic differences, the *Mapa de Santa Cruz* offers a depiction of the island city not unlike the *Uppsala Map.* Yet given their similarities, they are not identical. The *Mapa de Santa Cruz* did not incorporate all cartographic elements employed in the *Uppsala Map.* Noticeably absent in the upper left-hand quadrant of the island in the royal cosmograher's map is our lone narrative figure (Fig. 12). Is the absence of the *tlacuilo's* interlocutor simply an oversight on the part of royal cosmographer since we can also identify a number of native peoples in various activities in his own map? The answer to this question lies not in error or lapse of judgment by Santa Cruz, but rather in the idea of empirical observation.

For Santa Cruz, the colonial figure may have symbolized the idea that the *Uppsala Map* was made from empirical observation, a fact that was simply not the case for the *Mapa de Santa*

Cruz. We must remember that the royal cosmographer never set foot in Mexico City and thus any assertion to empirical observation on his part would have been false.

A Grey Wash

In support of the gaze, besides the gesticulations of arms, hand, torso, and head of the interlocutor, is the depiction of the island settlement. As noted before, the countryside is vibrant with color, which in turn, aided in highlighting human activities, flora and fauna, and topographic elements. But in marked distinction to how these environs are treated, the city was framed quite differently. Save to illustrate the canals of the city that channel their bluish waters, color was used sparingly at the viceregal capital. In the (relative) absence of color, a grey muted hue washed over the island.[17] Visually, this wash creates a chromatic field that underscores the island as a distinct space from the lakes and countryside. The grey wash also gives the city a somber feeling. On the surface, one could argue that the *tlacuilo* deemphasized the city to praise the lakes and countryside. Yet understating the island is also a function of the gaze. Again, Bryson's theory allows understanding the *tlacuilo's* chromatic field. He writes:

> Out of the indefinitely large number of hues in a given image, certain among them will be privileged, whether by overstatement or understatement, repetition or isolation, concord or discord with the *chromatic neighbourhood*.[18]

The art historian's emphasis on the "chromatic neighbourhood" as a component of the gaze aids in comprehending how the chromatic field of the *Uppsala Map* functions in *understatement*. Yet, the grey wash did not function alone, especially when considering that it is uninhabited. Except for our lone interlocutor, the island is empty. In reality, Mexico City was Spain's locus of human activity in the New World. Historian Charles Gibson has estimated that in 1560, the Indian

[17] A difference in hue is barely perceptible where the two sheets of parchment meet.
[18] Bryson, *Vision and Painting*, 119. Italics are my emphasis.

population of the island alone was roughly 80,000 and that it outnumbered the Spanish ten to one.[19] The absence of 88,000 permanent inhabitants, not to mention all those other people from the surrounding areas that converged upon the capital for their daily social, political, and economic needs, is quite noteworthy. If Mexico City was the locus of social activity in the basin—people walking the streets of the city or buying goods in its plazas—why then, did the tlacuilo represent it empty of any human activity?[20] The erasure of all things social served to magnify the city's urban character. This portrayal underscores the city as a physical unit, or *urbs*. A theory of *urbs* highlights, as Kagan has offered, the "design and magnificence of its buildings, the quality of its walls, and the layout of its squares and streets."[21] Let us now examine how the indigenous mapmaker described the architectural character of Mexico City.

A Cruciform Plan, a Renaissance Grid

As the *tlacuilo* correctly noted, the city has undergone a great urban transformation from its pre-Columbian predecessor depicted in the *Nuremberg Map.* Evidently absent is the built world of the Aztec. Missing is the twin-temple pyramid, the *Templo Mayor*, and ceremonial precinct that comprised much of the island settlement in the *Nuremberg Map.* As with any other pagan structure, it was demolished soon after Aztec defeat. However, not all that was indigenous was destroyed. Colonial Mexico City was a Renaissance-inspired city built over Tenochtitlan. We can locate the pre-Columbian past in two avenues in a sepia tone that intersect each other (just to the left of the cathedral) to create a cruciform plan. These avenues represent the four pre-Columbian causeways that helped to spatially order the island settlement. The depiction of a

[19] Gibson. *The Aztec Under Spanish Rule*, 378 and 380.
[20] For example, the market at San Hipólito, created in the 1540's, brought Spaniards and Indians alike from all parts of the basin (*ibid.*, 395).
[21] Kagan, *Urban Images of the Hispanic World*, 10.

quadripartite plan is not inconsequential. Although the Spanish demolished any building devoted to pagan ritualistic life, they could not remove all aspects of a pre-Columbian urban environment. Rather than portray the two urban planning traditions in opposition, the *tlacuilo* skillfully records how the colonial city fused into a single plan the ideals of both traditions: the cruciform plan and the Renaissance grid. As result, the (perceived) incommensurability of these two urban planning traditions is coalesced into a single frame.

Schematizing the Grid

It is important to note that the *tlacuilos* illustration of the city is unlike any other indigenous depiction of a Spanish city save one. Case in point, the *Relaciones geográfica* map of Cholula (of 1581) is as impressive portrayal of the city in that it shows its regularized urban plan, city streets, buildings, and interior and outdoor spaces, among others (Fig. 13). Presenting cities for their "documentary evidence" is highly unusual at this time for native mapmakers. Excluding these two maps, no other Indian-made maps identified Spanish cities to the point where they are physically verifiable. In marked contrast to the *Uppsala Map* and the *Relaciones geográfica* of Cholula, Indians drew Spanish cities quite differently. For example, in "Colony and Cartography: Shifting Signs on Indigenous Maps of New Spain," art historian Dana Leibsohn described how native mapmakers conceived of the Spanish city schematically.[22] Take for example, the 1582 *Relaciones geográfica* map of Teutenango (Fig. 14). Depicted is a series of four cities of various sizes. The plan of each settlement is illustrated diagrammatically: a central plaza surrounded by a grid. The mapmaker synthesized the Spanish city to its core components. Although we can locate some graphic commentary on a few of Teutenango's buildings, lacking

[22] Leibsohn, "Colony and Cartography," 265-281.

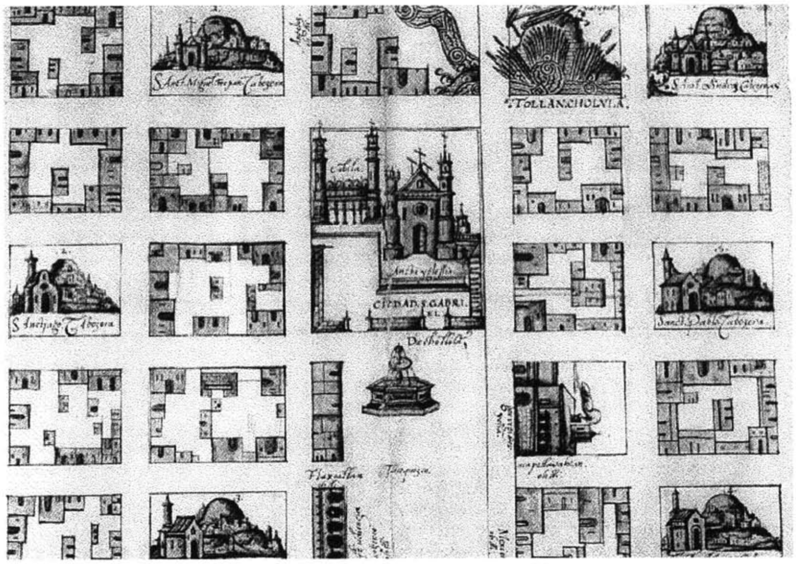

Fig. 13. Relación Geográfica map of Cholula, 1581. Size: 31 x 44 cm.
Source: Benson Latin American Collection, University of Texas at Austin (JGI xxx-1).

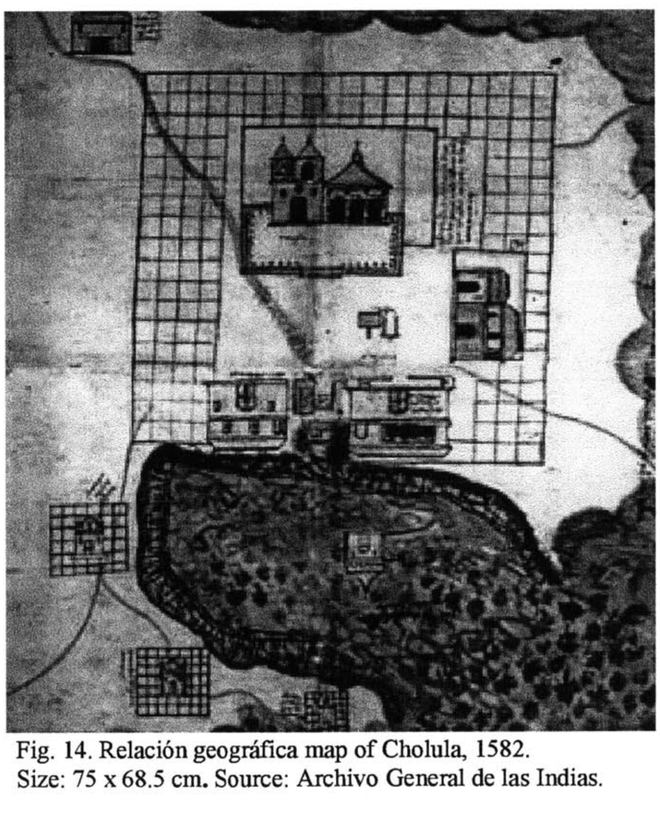

Fig. 14. Relación geográfica map of Cholula, 1582.
Size: 75 x 68.5 cm. Source: Archivo General de las Indias.

is any description as to the actual character of the city, its streets, or plaza.Indeed, the Spanish city was imagined as symbol. This is a recurring theme in native cartography of the sixteenth century, as a quick glance of the many maps of *Relaciones geográficas* will reveal. Leibsohn further argued that the schematization of the Spanish city lay not within the articulation of a "proper cartographic ground"—the descriptions of objects in ground plan—but rather within in a pre-Hispanic mapping tradition where cities, and topographical places were drawn as toponyms.[23] In turn, a schematized grid conveyed a community of Europeans living in a city.

A Renaissance City

Perhaps no aspect of the Mexico City spatial character has concerned historians more than its gridiron plan. For example, in 1948, art historian George Kubler wrote in *Mexican Architecture of the Sixteenth Century*:

> Within this great square, the traza included about fourteen streets, intersecting one another at right angles to form a gridiron plan with rectilinear block.[24]

In 1964, Gibson wrote in *Aztecs Under Spanish Rule: A History of the Indians of the Valley of Mexico, 1519-1810*:

> Inside the city, the first Spaniards began by marking off the central portion, an area of some thirteen blocks in each direction, as the zone of white occupation.[25]

Gibson, like Kubler, speaks to Mexico City's spatial regularity. Implicit in their commentary is an idea that the *traza* was laid out from its inception. Toussaint has argued that the *traza* was bounded on its eastern flank by the street of Jesús María, on the west, by San Juan de Letrán, on

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[23] *Ibid.*, 277-278.
[24] George Kubler, *Mexican Architecture of the Sixteenth Century* (Westport, Conn: Greenwood Press, 1972), 1:75.
[25] Gibson, *The Aztec Under the Spanish Rule*, 370.

the south, by San Miguel, and on the north, by Apartado.[26] As result of these offerings, the city has been conceived as spatially complete since its architect Alonso García Bravo planned it in the early 1520s.

However, the city was never a strictly defined geographical space, just as much as the "conquest" was not a single and definitive moment in time.[27] Perhaps the most perceptive commentary on how the viceregal capital comes not from twentieth-century scholars, but rather, from the author of the *Uppsala Map.* For example, the mapmaker depicted the portion of the city that adhered to a spatially enclosed space. Notice for example the limits of the *traza* in the southwest quadrant where our lone interlocutor is located. Here, a ninety-degree corner is formed and thus the mapmaker has identified the limits of the Spanish city by emphasizing the ideal of spatial regularity. In contrast to this spatial clarity, other areas of the city clearly lack defined boundaries. To begin, the eastern side of the Spanish city has no defined urban edge (towards the bottom of the city). In its place, we can locate an undulating street whose form speaks to no regularized spatial order. Tangentially, the "crookedness" of the street speaks to how people negotiate space at the local level. In another instance, we find no human-made boundary markers defining the limits of the city on its northern side edge. Perhaps not surprisingly, topographical features, such as the lagunilla—an inlet of water from Lake Mexico forming a small lagoon—and the canal of Tezontlalli define the city's edge. Clearly, the indigenous mapmaker did not conceive of the *traza* as a spatial unit insulated from the rest of the island settlement. Here, I am not arguing that the *traza* did not exist. Quite to the contrary, it was a political and social force

[26] Toussaint, "El plano de la Ciudad de Mexico," 571.

[27] The manner Matthew Restall's problematizes the conquest aids shaping my own thinking about the Spanish *traza*. For an understanding of Restall's deconstruction of "truths" related to the conquest, see the *Seven Myths of the Spanish Conquest* (Oxford: Oxford University Press, 2003).

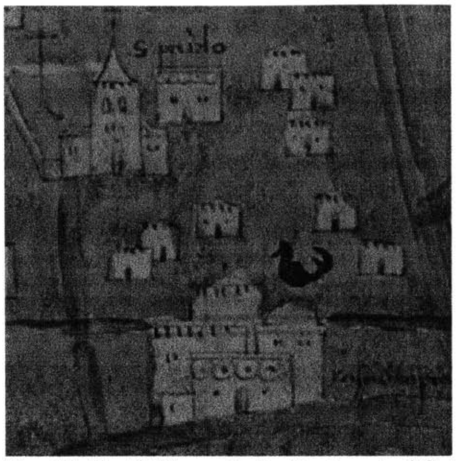

Fig. 15. Spatial Irregularity Southeast of Cathedral, *Uppsala Map* (Detail).

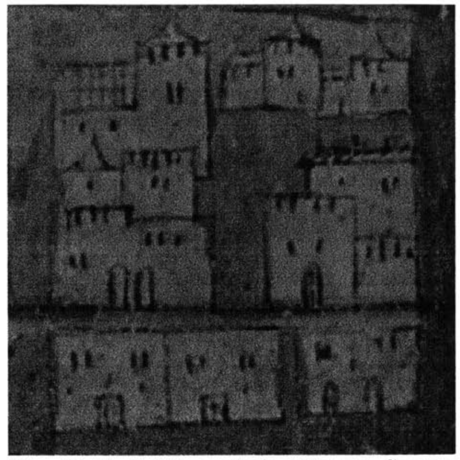

Fig. 16. Spatial Irregularity Western Sector of City, *Uppsala Map* (Detail).

that defined the city and its inhabitants, and by extension, those peoples and the places they live in outside the Spanish city proper. Rather, my argument is grounded in the idea that the overarching character of the *traza* was not set in stone when Alonso García Bravo planned the city as some scholar would have us believe.

Within the Spanish city, a partial grid is certainly visible. It was articulated in two ways. First, streets were illustrated by painting a sepia-colored avenue with buildings filling in the space around them. The second method suggests the presence of streets by arranging buildings in a manner that implies the existence of these avenues. Yet, the further away from the city center, the less regular is this spatial arrangement. For example, just southeast of the cathedral we find buildings loosely arranged in a manner that create a series of amorphous-shaped outdoor spaces (Fig. 15). In another example, in the western sector of the city, we can detect that a series of buildings form an undulating street (Fig. 16). These streets resemble the more organic arrangement of the Spanish medieval city and stand in marked contrast to the ideals of

Renaissance urban planning that Spain sought to implement in the New World.[28] These examples, and the few others still noticeable in the city center, reveal that Mexico City had yet to achieve spatial regularity by c. 1550.

Policía vs. *Vivir alárabe*

Maintaining spatial regularity was of great importance to Mexico City's *cabildo*, or city council. The city's orderly arrangement meant more than just a handful of streets arranged parallel to each other and intersecting one another at right angles. In the New World, the urban grid plan was the very essence of Spanishness. Equally as important, this thesis constructed its antithesis, *vivir alárabe*.[29] Literally translating "to live like an Arab," it was a concept that to the Spanish described the manner in which Moors lived in Spain—in cities that lacked "order"—and thus signifying the so-called qualities of Spanish Muslims—uncivilized, disorderly, and perhaps most important of all, living a non-Christian way of life. Once in the New World, the underlying tenets of *vivir alárabe* did not change, but there was one significant difference. Whereas in the Iberian Peninsula it referred to the manner in which Moors lived; in Mexico, the term was applied to the manner in which Indians lived.[30] *Vivir alárabe* thus can be understood as part of a transportable trans-Atlantic ideology where Indians and Moors were interchangeable. But its application to non-Christians in the Iberian Peninsula and the New World was but one pole of a binary relationship. At the other end of this social bond, stood the Spanish. If *vivir alárabe* characterized an irregular settlement pattern, how did the Spanish conceive orderly cities?

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[28] For an understanding of the Spanish planning ordinances, see "Ordenanzas de descubrimiento, nueva población y pacificación de las Indias."

[29] Kagan, *Urban Images of the Hispanic World*, 27.

[30] Ironically, the Spanish marveled at Tenochtitlan's spatial regularity when they first set their eyes upon the city. Given the strict arrangement of its central plaza and quadripartite plan, it stood in contrast to the irregular settlement patterns of the Indian barrios. The latter was the focus of a New World version of *vivir alárabe*.

For the Spanish, an orderly city was the locus of civilized life in the New World. A town, regardless of its size, having a gridiron plan embodied good government, republic, social order, and most important of all, Christian values.[31] Such a plan was synonymous with *policía*, a term that signified, as Kagan put forth, "a community whose citizens were organized into a republic."[32] *Policía*, not unlike *vivir alárabe*, had a spatial dimension that identified the character of its inhabitants. Since the Spanish cities in the New World lacked city walls (except for city ports), the quality of a settlement was defined by the regularity of its streets that intersected one another at right angles. The contrast between the gridded city and the irregular Indian barrios helped the Spanish to position *policía* against *vivir alárabe*, and by extension, marked a spatial distinction between Spaniards and Indians. However, unlike in Spanish Iberians cities were *mojones*—a series of stone markers—marked the city's perimeter and thus drew a line between Christians and Muslims, in the New World, the line between Spaniards and Indians was drawn with the gridiron plan. To be more specific, the streets defining the *traza's* edge where the *mojones* of the New World, and all that was external to it was *vivir alárabe*. If we return to our narrative figure, we can clearly see that he stands holding the *traza's* edge with his left hand.

As previously noted, the *tlacuilo* identified several places within the Spanish *traza* that resembled unplanned growth. As a result, the mapmaker alerts us to a dilemma regarding Mexico City's urban plan: the *traza* was not wholly uniform. If the Spanish city was to be the site of *policía*, then any irregularity, no matter how inconsequential it had to be rectified immediately. The irregularity presented within the Spanish city puts us in the crosshairs of a historiographical conundrum. In theory, Mexico City was planned according the urban planning ideals of the Italian Renaissance, but in practice, we find moments where this was certainly not the case.

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[31] Kagan, *Urban Images of the Hispanic World*, 27.
[32] *Ibid.*

These instances, however small, challenge the historiography on the city's urban plan. Yet, this discrepancy becomes more apparent when analyzing Mexico City's *actas de cabildo* or city ordinances. By studying these ordinances, we are afforded a perspective about the city that coincides with the *tlacuilo's* commentary.

Mandating Colonial Regularity

Evident in many of the ordinances mandated by the city council prior to 1550 is an anxiety about the city's spatial form. This administrative body was greatly concerned with any development that resembled unplanned growth or *vivir alárabe*. If left unattended any spatial irregularity jeopardized the *policía* that the city aspired to achieve, and by extension, would endanger all semblance of civilized life in Mexico City. To ensure that the city was built according to the principles set out by Alonso García Bravo, the *cabildo* had to interject in matters that today we conceive as the world of building departments and city planners. As early as December 20, 1532, the city council decreed into existence a body of building inspectors when it demanded that no new building foundation could be laid without the mayor and its council members present to supervise that the city's regularity was maintained.[33] Like many laws that are enacted after a violation occurs, this one was no different. This specific decree went on the city books after several Spaniards constructed their respective homes into the city's streets. In another example, the city council noted, on July 21, 1536, receiving several complaints about buildings erected into city avenues.[34] But perhaps what is most significant about these violations is that the

[33] Actas de Cabildo (hereafter A. C.) December 20, 1532 in *Actas de Cabildo del la Ciudad de México*, ed. Ignacio Bejarano, 54 vols. (Mexico City: Imprenta y libreria de Aguilar e hijos, 1889-1911). The penalty for violating the council's decree was twenty *pesos de oro* of which one-third would go to funding public works projects with the other two thirds being divided between the judge and the accuser. Additionally, the building in violation would be demolished.
[34] A. C., July 21, 1536.

council conceived of them as putting in danger *pullicia* [sic].

At risk of *vivir alárabe*, the *cabildo* found no choice but to decree the demolition of buildings found in conflict of *policía*. One of the earliest documented cases where the city council ordered the removal of a structure occurred on November 28, 1539.[35] In this particular instance, the city council ordered Rodrigo de Casteñeda and Francisco Dávila to demolish their respective buildings within three days' time. However, since previous requests to tear down their structures had fallen on deaf ears, the council also empowered themselves to remove the buildings after a seventy-hour window had elapsed, but at the owners' expense. Not even high-ranking officials or religious orders were exempt from prohibitions against violating the regularity of the *traza*. For example, Cortés—the principal figure in founding Mexico City—was discovered to be guilty of violating the regularity of the *traza*. On August 9, 1532, he, along with the conquistadors Gil González de Benavidades and Juan Cano, were given eight days to bring their buildings into compliance.[36] Likewise, the Augustinian Order was mandated to adhere to the *cabildo's* building ordinances.[37] One would think that after Cortés and the Augustinians were ordered into compliance that all others would follow. However, this was simply not the case. On October 12, 1540, the city council was forced to reiterate the importance of not deviating from an orderly city plan.[38] As before, they were concerned with buildings that encroached into city streets, and not unlike their decree of July 21, 1536, they were deeply worried of how these violations endangered the city's *policía*. The city council also planned for the day that the city would expand beyond its original footprint. Specifically, only eleven years after the city was founded, on November 27, 1535, the council planned for growth northward across the *lagunilla*

[35] A. C., November 28, 1539.

[36] A. C., August 9, 1532.

[37] A. C., March 16, 1540. In this case, pillars that extended beyond the *traza* were ordered removed.

[38] A. C., October 12, 1540. The city council worried that the city streets were losing their orderly form because of buildings constructed into the streets. See also A. C., January 15, 1545.

to Tlatelolco.[39] With the idea of expansion in mind, they decreed that no building should be constructed in the path of the yet-to-be built city streets that would eventually unite Mexico City with Tlatelolco.

Mandating the architectural character of Mexico City's streets was one of many "spatial" issues that the council undertook to produce *policía*. Others centered on the cleanliness and hygiene of the city, and the materiality of its avenues. With respect to the former, the city council set out to smother even things biological if it endangered *policía*. From 1545 to 1548, Mexico City was under siege at the hands of a plague. With no natural ability to withstand the epidemic, one-third of all Indians living on the island died.[40] The city council determined that the cause of the outbreak was the unsanitary conditions of the city, brought about primarily by the Spanish habit of accumulating rubbish in city streets or in undeveloped *solares* (building lots). To bring the epidemic to an end, the city council decreed on March 26, 1545 that all city streets and *solares* had to be cleaned.[41] Such an important task could not be left to the accord of individual Spaniards, given their lackadaisical response to many of the council's previous decrees. To circumvent an attitude of non-compliance, the council hired Francisco Galindo to undertake this very important task, with the cost of his service to be passed onto the city's property owners. On other occasions, the council prioritized the paving of the city's thoroughfares. Not unlike the boundary between a regularized city plan and an amorphous one marking a spatial difference between Spaniards and Indians, the materiality of Mexico City's streets would also highlight this distinction. Indian paths were made of earth, but so too, the streets of Mexico City. Surely, Spain's capital in the New World could not be made of the same materials as Indian paths. In the

[39] A. C., November 27, 1535.
[40] Gibson, *The Aztec Under the Spanish Rule*, 62.
[41] A. C., March 26, 1545.

eyes of the *cabildo*, city streets were royal; council decrees often referred to them as *calles reales*. As early as 1547, the city council began enacting a series of ordinances that would transform the material character of the city's earthen roadways to cobblestone.[42] Viceroy Mendoza viewed these edicts with particular favor, when on November 22, 1548, he commented that the work was indispensable for achieving *policía*.[43]

Cal y Canto

One of the peculiarities of the *Uppsala Map* is how the facades of buildings are illustrated. Regardless of their actual orientation, all facades are presented to the viewer. This fact is quite unusual, especially when considering that at least 1,700 structures are depicted in the *Uppsala Map*.[44] European-style structures account for twelve percent of the buildings shown with Indian adobe homes accounting for the remaining eighty-eight percent.[45] A prime example of this "turn" is the city's cathedral and its adjacent plaza (Fig. 17). In reality, this building's façade faces south towards the plaza (to the right), a fact that would not permit us to see its single nave and two turrets with pointed roofs flanking its sides. If the cathedral were presented accurately, given the map's orientation, we would see this building's east wall. The *tlacuilo* made no distinction between civic and privately-owned buildings, as the facades of the

[42] A. C., March 14, 1547; A. C., July 17, 1551; A. C., September 9, 1552; A. C., September 3, 1554; and A. C., October 26, 1554.
[43] A. C., November 22, 1548. Residents who owned homes on the streets designated for paving were required to pay twenty *pesos de oro* towards materials and labor.
[44] Evans, "The Aztec Palace under Spanish Rule," 28. Structures fall into categories of house/administrative building, church, and other kinds of buildings such as hospitals and mills.
[45] *Ibid.*

Fig. 17. Façade of Cathedral, *Uppsala Map*, (Detail).

latter are also presented in this manner. As with the material character of city streets, the council also regulated the materials employed in dressing Spanish buildings. One of the first decrees enacted about the aesthetic nature of colonial buildings occurred on September 27, 1535.[46] This specific decree called for building façades to be dressed in *cal y canto*, literally translating as "calcium and stone." But, in actuality, it referred to masonry construction. As part of this decree, they also prohibited the use of adobe for any façade. It was an ordinance that was reissued in less than three years' time, when on April 11, 1538, the city council again decreed that facades of Spanish building be made of *cal y canto*.[47] The recurring endorsement of masonry

[46] A. C., September 27, 1535.

[47] A. C., April 11, 1538. Other mandates of this decree included: (1) that within one year after a *solar* (building lot) was granted that a building be constructed, or at the very least that the property be enclosed with a fence; (2) that the construction not encroach upon another's property, city streets, or canals; (3) that the soil and rock of the *solar* could not be used elsewhere; (4) that the *solar* must be used as a personal residence and for no other reasons; (5) that one could not enter his *solar* through the property of a neighbor, such as through a corral or garden; and (6) that one could only sell his property after living a minimum of five years in the city. A few years prior, the city council prohibited the removal of a *solar's* soil and rock for uses not related to that specific property (A. C., September 27, 1535). The punishment for violating the decree was not equally applied. Depended on the ethnicity of the perpetrator, penalties varied. If Spaniard was found in violation of the decree, a ten *pesos* fine was levied. Half of the fine went towards paying for public works projects and the other half was divided between the judge and the witness reporting the violation. If Indian violated the decree for his personal gains, he was to receive fifty lashes. The penalty was commuted if the he was found to be working for a Spaniard.

construction marks a critical turning point in the aesthetic nature of the Spanish *traza*. Until this moment, many Spanish building employed adobe as a building material. Adobes were easily accessible because they were simple to make, relatively inexpensive, and formed part of an Indian building technology (used in their own homes), which was redirected towards Spanish building needs. Adobes were synonymous with Indianness, and as a result, the *cabildo* desired to break free from this association when calling for masonry construction. Like the orderly grid, cobblestone, masonry construction would highlight an architectural difference between Spaniards and Indians to cement a distinction between *policía* and *vivir alárabe*.

De Facto Urban Planners

The *tlacuilo* provides us with an image that suggests Mexico City was still a work-in-progress in c. 1550. In addition, the planning edicts showed that the city's regularity was dependent on the city council and not an architect's plan. Clearly, the *cabildo* was not unfamiliar with Renaissance urban planning principles and for their desired effect of achieving *policía* in the New World. The *cabildo* most certainly understood its significance to the fledging colonial city, and as a result, sought to curtail any urban development that deviated from a regularized plan. These edicts call attention to the council's role as *de facto* urban planners. But how can we conceive of a political body, who through city ordinances, designed Mexico City?

The Uruguayan literary critic Ángel Rama noted in *The Lettered City* the importance of a "social rank of 'lettered' functionaries"—administrators, notaries, educators, judges, among many other professionals—in Spanish America.[48] These, Rama highlights, were men of letters who in their everyday practice of their given professions wrote the official language of the

[48] Ángel Rama, *The Lettered City*, trans. and ed. John Charles Chasteen (Durham: Duke University Press, 1996).

Spanish colonial enterprise. Imagine if you will, men sitting behind a large desk with no practical experience in design or construction, armed with ink, quill, and paper writing into existence the order of colonial Spanish America. Although primarily concerned with how the *letrados* were centered in cities as the seat of Spanish administrative authority, Rama provides us a perspective for understanding the disjuncture between the idealized city and the one of brick-and-mortar. Prior to his untimely death in 1983, he wrote:

> Accordingly, from the time of their foundation the imperial cities of Latin America had to lead double lives: on the one hand, a material life inescapably subject to the flux of construction and destruction, the contrary impulse of restoration and renovation, and the circumstantial intervention of human agency; on the other hand, a symbolic life, subject only to the rules governing the order of signs, which enjoy a stability impervious to the accidents of the physical world. Before becoming a material reality of houses, streets, and plazas, which could be constructed only gradually over decades or centuries, Latin American cities sprang forth in signs and plans, already complete, in the documents that laid their statutory foundations and in the charts and plans that established their ideal designs.[49]

Rama's distinction between a theorized city and a built one is significant. It begins to answer the question of why Mexico City's plan did not always coincide with its idealized version. With Rama's perspective in mind, we can thus conceive of Spanish cities as both composed of brick-and-mortar and of ink-and-paper. Indeed, in the case of Mexico City, these were deeply intertwined. As early as December 20, 1532, in the *actas de cabildo*, we find the first mention of the *traza*, but it is not the place that men, woman, and children inhabit.[50] Rather, the *traza* was a map of the Spanish city.[51] It, according to the *acta* and later decrees (of September 27, 1535 and November 27, 1535) also spoke of the *traza* as a map that would aid the *cabildo* in "seeing" the city in its idealized form.[52] Art historian Thomas B. F. Cummins referred to this process as an "imaginative act of vision," when describing how the conquistador

[49] *Ibid.*, 8-9.
[50] A. C., December 20, 1532.
[51] Unfortunately, the location of this map is not known.
[52] A. C., September 27, 1535; A. C., November 27, 1535.

Francisco Pizarro planned the city of Lima in Peru in accordance with a drawing as he walked the yet-to-be-constructed city.[53]

Rama's theory of the "lettered functionary" helps us understand the important role the *cabildo* performed regarding urban planning. For a very different context in *Imaginary Cartographies: Possession and Identity in Late Medieval Marseille*, historian Daniel Lord Smail makes the case for understanding the city's spatial character from textual documents, and specifically, from notarial culture.[54] Despite the absence of maps for medieval Marseille, Smail identified how notaries in pre-modern Marseille invented a method for mapping land ownership, a process he termed "linguistic cartography." Linking to Rama's insights, this helps us understand that underscoring Mexico City's spatial character was a cadre of men, "lettered functionaries." These men in writing decree after decree about the city's spatial regularity and its material and aesthetic qualities wrote into the *actas de cabildo* a linguistic map for producing the ideal architectural character of the city. As a result, the *cabildo*, men not trained in design and urban planning, but rather a legislative body appointed to govern the city, turned into *de facto* urban planners when working towards instilling *policía* into the brick-and-mortar of the fledging capital.

[53] Thomas B. F. Cummins, "A Tale of Two Cities: Cuzco, Lima, and the Construction of Colonial Representation," in *Converging Cultures: Art and Identity in Spanish America*, ed. Diane Fane (New York: Harry N. Abrams, 1996), 159.
[54] Daniel Lord Smail, *Imaginary Cartographies: Possession and Identity in Late Medieval Marseille* (Ithaca: Cornell University Press, 2000).

"Interior de la Ciudad de México"

Mexico City's architectural character was a subject taken up by the humanist Francisco Cervantes de Salazar in his *Tres diálogos latinos* of 1554.[55] They are perhaps the most illuminating textual descriptions of the city from the sixteenth century. Salazar was no ordinary man.[56] In Spain, he taught at the University of Osuna, and once in Mexico City, he was one of the first professors of the newly established university—founded in 1553 by royal decree of Charles V—as well as chair of rhetoric.[57] The first of the three dialogues examined the university; the second, the city; and the third, the countryside. It is the second dialogue entitled, "Interior de la ciudad de México" ("Mexico City's Interior") that concerns us. Salazar, aided by three interlocutors—Zuazo, Zamora, and Alfaro—reflected upon the architectural character of the island settlement. Zuazo and Zamora are *vecinos*, Spanish for residents of the city, while Alfaro is a *forastero*, or newcomer. The three men begin their journey of the city on horseback on Tacuba Street, an intentional act on the part of Salazar that allowed him to draw out the praise of Alfaro. Before the men can even begin their exploration, the newcomer is overwhelmed by the quality of the street, exclaiming:

> ¡Cuan larga y ancha!, ¡que recta!, ¡que plana!, y toda empredada, para que en tiempo de agua no se hagan lodos y esté sucia.[58]
>
> How long and wide! How straight! How level! And all of it paved so in time of rain there will be no mud and become dirty.

Alfaro was barely able to take in the splendor of Tacuba Street when Zamora asked for the newcomer's thoughts on the orderly arrangement of Spanish buildings lining the avenue.

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[55] Francisco Cervantes de Salazar, *México en 1554: tres diálogos latinos de Francisco de Cervantes de Salazar* (Mexico City: Universidad Nacional Autónoma de México, 2001).
[56] For further reading on Francisco Cervantes de Salazar see, Zelia Nuttall, "Francisco Cervantes de Salazar: Biographical Notes," *Journal de la Société des Américanistes*, 13, no. 1 (1921): 59-90.
[57] Catholic Encyclopedia. Francisco Cervantes de Salazar. http://www.newadvent.org/cathen/03545a.htm. Accessed June 12, 2012.
[58] Cervantes de Salazar, *México en 1554*, 23.

Alfaro commented on their magnificence, noting that they were surely made at a great cost, and that these were certainly the homes of noble and opulent men. He also marveled at the lintels and jambs of these home's doorways, observing that they were not made of brick, or some other "vile material," but rather the product of great stonework with their construction nothing short of "artistic."[59] Likewise, the city's plaza also drew the accolades of the newcomer:

> ¡que regularidad!, ¡que belleza!, ¡que disposición y asiento![60]
>
> What regularity! What beauty! What arrangement and great form!

In response to the stranger's amazement, Zuazo adds that while Rome had four plazas, Mexico City's single square was the sum of the ancient ones.[61] In comparing the New Spanish plaza to those of classical Rome, we find an appreciation for antiquity, but at the same time, Cervantes de Salazar points out that while inheriting this tradition, it was improved upon in Mexico City. Later, as the men traveled through the city, the *diálogo* turned to the fineness of other structures, such as the cathedral, convents, and churches. Only after Alfaro has seen the sumptuous nature of the city is he shown the rest of the island settlement. Taken to the edge of the Spanish city, Zuazo pointed out to Alfaro the Indian barrios as a method for comparing the city. "Notice how the Indian homes barely rise above the earth," Zuazo exclaimed to Alfaro, a reference to their simple construction. In turn, the newcomer quickly noted the lack of any spatial order, a comment on their irregular settlement patterns. Without any further discussion, the men turned their backs to the Indian barrios to once again examine the Spanish city. As lunchtime neared, the men prepared to end their travels of the capital, upon which Alfaro commented that a "great dormant appetite" has been "awakened."[62] The *diálogo* ends with the men sitting down for lunch.

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[59] *Ibid.*, 24.
[60] *Ibid.*, 26.
[61] *Ibid.*, 27.
[62] *Ibid.*, 59.

Cervantes de Salazar's "Interior de la Ciudad de México" is the literary counterpart of the *Uppsala Map*. "Read" together they provide comprehension as to the intended spatial character of viceregal Mexico City. Although implicit in both "narratives," they speak to the ideal of living in *policía*. The *cal y canto* of the city's building that the *tlacuilo* described in his map was captured in the Alfaro's amazement; the regularity of the city and its plaza was demonstrated by the newcomer's words when offering that a "great dormant appetite" was "awakened." Clearly, both "narratives" convey the essence of Spanishness in the New World. We must keep in mind that the *diálogos* followed the *Uppsala Map* by roughly four years. The mere fact that both are produced within years of each other suggests an underlying concern with describing the city, while highlighting it as the locus of Spanish virtue. As a result of these similarities and the short temporal distance between them, we can envision the *diálogos* and the *Uppsala Map* as counterparts cut from the same intellectual swath. Yet the Indian mapmaker went beyond Cervantes de Salazar's description of the city. For the mapmaker, the city was still a work in progress.

An "Unhealthy" Site

In the *Uppsala* Map, the *tlacuilo* offered a perspective of the city's relationship to the lakes. With an aquatic urban fabric in mind, the *tlacuilo* depicted how the island was protected by two dikes on its eastern edge. The furthest away, and the oldest, was the dike of Nezahualcóyotl (previously discussed in my analysis of the *Nuremberg Map* in Chapter 1).[63] The

[63] The dike of Nezahualcóyotl was built a quarter of a league east of the dike of San Lázaro. AGN, Desagüe, vol. 3. f. 330 v. This reference comes from an unpublished report on the 1629 flood by the Carmelite friar Andrés de San Miguel entitled "Relacíon del sitio, trabajos, y estado de la Ciudad de México, y de su remedio, hecha a nuestro padre General Fray Esteban de San José, para que pareciéndose a su reverencia lo ponga en la manos de su majestad, Año de 1631." For the published version see, Andrés de San Miguel, *Obras de fray Andrés de San Miguel*

Fig. 18. Canals and Dike, *Uppsala Map* (Detail).

second dike, San Lázaro, was built after Nezahualcóyotl to protect the city from any floodwaters when the latter was deemed ineffective. Notice how San Lázaro carefully follows the island's eastern undulating shoreline, thus shielding the city from harm by rising waters. Although not described in any great detail, save for a single "opening" located at the center of this dike, seven floodgates corresponded to an equal number of canals (Fig. 18). These waterways crossed the city from west to east. Floodgates and canals worked in unison to ensure that water levels within the island city did not rise substantially, thus endangering the capital with inundation. To prevent significant fluctuations in water levels, floodgates were opened in the mornings, allowing any water that had been deposited into Lake Mexico by rivers and streams from the mainland hills west of the city to make their way through the canals, eventually exiting through the openings at San Lázaro. In the afternoons, these gates would be closed, preventing Lake Mexico's waters from being blown back into the city by afternoon winds.[64]

ed. Eduardo Báez Macías, 322-343 (Mexico City: Instituto de Investigaciones Estéticas, Universidad Nacional Autónoma de México, 2007).

[64] Cepeda, Carrillo, and Serrano, *Relacion universal*, 40-41.

In highlighting the two dikes, the *tlacuilo* described hydraulic elements whose primary purpose was to prevent flooding. However, when flooding was not imminent, the lakes required regulation of a different nature. The opening and closing of floodgates in the morning and afternoon addressed an everyday practice of living in an aquatic setting. Both examples thus highlight a two-tier water management approach. Differences in this approach can also be noted by the way the *tlacuilo* described different parts of the island. For example, no dikes or floodgates were depicted on the western side of the city. The lack of these structures on this side of the island suggests that any water deriving from the western side was not viewed as perilous. To the contrary, it was beneficial to the island. In the case of the aqueduct of Chapultepec, it brought much-needed drinking water to the island, which lacked its own supply. On the other hand, the eastern shoreline, as already noted, was built-up with a series of hydraulic elements that radiated outward from the shoreline to protect the city in times of flooding, and when not in immediate danger, to regulate the city's water levels. Perhaps no more evident of these contrasting characteristics is the manner in which these respective shorelines were settled. For example, on the western side of the island, we find a number of Indian homes on *chinampas* located in the lake between the island and the mainland (Fig. 19). The northern side of the island was also depicted as an area not particularly concerned with flooding. But in noticeable contrast, the eastern side is treated quite differently. A quick glance of the *Uppsala Map* reveals that Indians homes were constructed up to the dike of San Lázaro, but not beyond it, suggesting the danger of building further east and risking exposure to any potential floodwaters (Fig. 20). Indeed, the *tlacuilo* crystalized the island's hydrographic character by illustrating its multi-layered approach for water management that included flood control.

Fig. 19. Western Hydrographic Condition *Uppsala Map* (Detail).

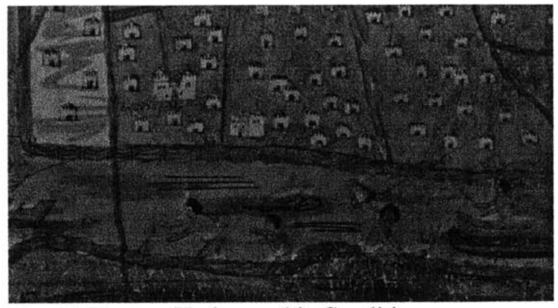

Fig. 20. Eastern Hydrographic Condition, *Uppsala Map* (Detail).

Once again, we can turn to municipal decrees to compare them against the *Uppsala Map*. As in the urban form of the city, hydraulic elements—natural and built—were also part of the city council's jurisdiction. However important these hydrographic structures were for regulating water levels, the natural setting of the island posed a new set of conditions, and by extension, challenges, that the *cabildo* was not fully prepared to understand. Historian of medieval and early modern Spanish hydraulic technology Thomas F. Glick has shown in *Irrigation and Hydraulic Technology: Medieval Spain and its Legacy* that Spain had a long and rich history of water management practices in the Iberian Peninsula.[65] However, by extrapolating from Glick's research on irrigation canals, noria pots, and water mills, among other water-related structures, we can deduce that these experiences would have provided the Spanish with limited opportunities for understanding the magnitude of Mexico City's aquatic setting. Indeed, the city's lacustrine environment was unlike anything the Spanish had encountered in their Iberian homelands.[66] Simply put, the Spanish lacked an appreciation for the delicate balance between land and water that comes with living on an island for centuries.

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[65] Thomas F. Glick, *Irrigation and Hydraulic Technology: Medieval Spain and its Legacy* (Aldershot, Hampshire, Great Britain; Brookfield, Vermont: Variorum, 1996).

[66] When the Spanish first set their eyes on Tenochtitlan, the comparisons to the island city of Venice immediately began. For a study of that examines images of both cities, see David Y. Kim, "Uneasy Reflections: Images of Venice and Tenochtitlan in Benedetto Bordone's 'Isolario,'" *RES: Anthropology and Aesthetics* no. 49/50 (Spring – Autumn, 2006): 80-91.

Once the Spanish settled the island, the balance between the city and its aquatic setting began to change. For example, Gibson had noted that this change was founded, in part, on the Spanish favoring streets instead of canals.[67] As a result, the Iberians began the process of filling in canals to make way for streets that would allow for mule- and horse-drawn carriages.[68] Occasionally, we find a municipal decree mandating that these filled-in waterways be returned to their former state. However, in general, very few edicts regarding the overall condition of the hydraulic network were placed on the city's books prior to 1550. The (relative) absence of these types of ordinances, speaking to the hydraulic nature of the capital, suggests a lack of concern for the service these provided towards regulating the lacustrine environment. By extension, it also reveals a lack of anxiety towards keeping Mexico City and its inhabitants safe from inundation. Interestingly, the Spanish were not blind to the island's shortcomings when they founded the capital. Gibson highlighted how Cortés' men were concerned with the island's limitations, repeatedly warning their captain about them.[69] Kubler offered a more comprehensive description of the island's inadequacies:

> Early in 1522, Cortés took the decision to rebuild Tenochtitlan as the metropolitan center of the colony. The issue was whether or not to place the capital city upon an island, and the decision followed upon much debate and difference of opinion. The arguments against settling upon the island were numerous and convincing. It was low-lying, marshy, and constantly subjected to disastrous floods. It had the reputation of being unhealthful, a reputation hardly improved by the devastation of the Conquest, when the besiegers destroyed the city by filling in the canals with the debris of buildings, to allow the maneuvers of cavalry. It was incapable of sustaining any agrarian or stock-raising activity, in the absence of pastures, fields, and springs. The problem of water-supply needed solution by expensive artificial means. It communicated with the mainland over causeways, and the colonists felt that these causeways, with their easily invested bridges, would be dominated by the Indians of the mainland rather than by the island Europeans. In short, some thought the site was a trap, incapable of resisting siege, and peculiarly vulnerable in its provisioning and water-supply.[70]

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[67] Gibson, *The Aztecs Under the Spanish Rule*, 385.

[68] Enrico Martínez, "Relación de Enrico Martínez architecto [sic] y maestro de la obra del el desagüe de la Laguna de México," in *Memoria histórica, técnica, y administrative de las obras de desagüe del valle de México, 1449-1900*, ed. Junta Directiva del Desagüe del Valle de México (Mexico City: Tipografía de la Oficina Impresora de Estampillas), 2:6; Mathes, "To Save a City," 425; and Hoberman, "City Planning in Spanish Colonial Government," 25.

[69] Gibson, *The Aztecs Under Spanish Rule*, 368

[70] Kubler, *Mexican Architecture of the Sixteenth Century*, 1:69.

As Kubler indicated, the island was an extremely poor site for founding the capital. Cortés' decision to settle the island was not insignificant, especially when considering that Spain's planning edicts for selecting sites in the New World, based on Vitruvian planning ideals, strictly forbade choosing an "unhealthy" site. Although Cortés' decision fell in line with a late Spanish medieval practice. As Moorish city after Moorish city fell into Christian hands during the *Reconquista*, the Spanish settled these conquered towns as their own. In this respect, founding Mexico City at Tenochtitlan repeated a practice of conquest, regardless if unconcerned that the site was "unhealthy." As a result, Cortés' decision, based on the benefits of occupying the site of a former enemy, the Spanish were placed in a physical setting that they were ill prepared to manage.

The absence of municipal decrees regarding the hydraulic network indicates a disregard for Mexico City's natural setting, and by extension, the safety of its inhabitants. Compared to edicts mandating the spatial, material, and aesthetic character of the city, the difference between the former and the latter is illuminating. In the decrees pertaining to the latter, we find an anxiety about the architectural character of the city, while in the former, we are hard pressed to locate a similar concern. In this sense, the absence of edicts focused on water-related matters and structures highlights the disregard of the Aztec hydraulic network by the Spanish. Spanish disregard for pre-Columbian method was a cause for concern. Even when the network was maintained in Aztec times, it did not always prevent flooding. But in the early colonial period when it garnered little attention by the *cabildo*, it was an accident waiting to happen.

Conclusion

There is no better example describing the spatial character of the Spanish viceregal capital in the sixteenth century than the *Uppsala Map*. The map was made at a time when no maps of the viceregal capital were known in Spanish circles. To magnify the importance of the map, it was made of the *muy noble, insigne, y leal ciudad* (in English, the *very noble, illustrious, and loyal city*), a title Charles V granted Mexico City by royal decree in 1545.[71] It is striking that an Indian cartographer was selected to make the *Uppsala Map*. The reason why a native mapmaker was chosen is complex, but briefly, the Spanish turned to Indian cartographers in the sixteenth century given the absence of European mapmakers in the New World.[72] The *tlacuilo's* claims about the viceregal capital's architectural character demands that we reexamine our understanding of the settlement. The portrayal of the colonial city in the *Uppsala Map* strongly suggests the form of the *traza*—its boundaries and regularity—was not set in stone from its founding inception as scholars would have us believe. The map thus offers an alternative perspective regarding the city's historical path of development. Such a viewpoint is centered on the fact that the settlement was still very much a work-in-progress in c. 1550. In line with this assessment are the *actas de cabildo*. Analysis of these municipal decrees confirms the *tlacuilo's* cartographic commentary. These ordinances highlight a concern for the spatial, material, and aesthetic character of the city when aspiring to achieve *policía*, a theory that stood in marked contrast to *vivir alárabe*.

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71 Linné, *El Valle y la Ciudad de México*, 51.

72 One reason why the Spanish looked to native mapmakers when in need of a map can be found in the *Relaciones geografica* report to the *Villa de Espíritu Santo*. Although the accompanying map was made the European Francisco Stroza Gali, Suero de Cangas y Quiñones, the mayor of *Espíritu Santo*, offered that the map was drawn as best as possible given the lack of a painter. See the *Relaciones geográfica* report for Villa de Espíritu Santa dated April 29, 1580.

If a resituating of the *traza* in the historiography is the only requirement of the *Uppsala Map*, then it is a task of significant importance. However, the map demands a lot more of us. It obliges us to consider how the native mapmaker conceived his commission. The *tlacuilo* created a narrative figure that implies the first-hand reliability of the map, but goes on to convey, by its dynamic corporal expression and especially its arms and hands, a forthright demand that the city be examined, asserting his own claim to command the nature of sixteenth-century Mexico City.

The *Uppsala Map* is important for one more reason. Notably, the mapmaker offered a perspective of the architectural character on Mexico City, built within three decades after the Spanish defeated the Aztec. Even as a work-in-progress, it was still an impressive settlement as Francisco Cervantes de Salazar noted in his *Tres dialogos latinos* of 1554. Equally important, the *Uppsala Map* records the city just a handful of years prior to the city entering a four-year period of flooding. With the floods of 1552, 1553, and 1555, the Spanish began to understand the consequences of Cortés' decision to settle the island. With these inundations, the Iberians soon began to question the pre-Hispanic method for mitigating floods. Doubting the ability of the causeways, dikes, and floodgates to protect the city meant that a new method would have to be considered. Just five years after the *Uppsala Map* was made, the *desagüe* was discussed for the first time.

Chapter 3:

Mapping Drainage, 1552-1607

Medieval and early modern hydraulic practices in the Iberian Peninsula provided the Spanish with few opportunities to understand the scale of their New World setting. Water management to the extent required by Mexico City's aquatic environment was uncharted territory for the Spanish. Fortunately for the newcomers, inundations were not everyday occurrences. Colonial authorities were thus not impelled to immediate action to protect the city from deluges as soon as they settled the island in 1524.[1] Spanish inexperience towards flood control on the magnitude required by the viceregal capital, combined with the infrequency of inundations, produced an era that saw little to no hydraulic planning during the earliest days of the colonial period. Indeed, decades could pass with no threat of flooding. This was certainly the case during the first thirty years of Spanish colonial rule. However, this period of calm waters could not last forever. Within a handful of years after the *Uppsala Map* was made, the Iberians entered a new phase in the history of Mexico City water management. After living deluge-free for three decades, the city was inundated three times within the span of only four years. While the frequency of these floods—in 1552, 1553, and 1555—was indeed to prove a rare occurrence, they highlighted even more the island city's susceptibility to inundations. In later years, the incidence of flooding significantly decreased, with the city afflicted by only three floods, in 1580, 1604, and 1607, in five decades after this short, but intensive period of deluges ended.

This chapter examines Spanish flood control practices from 1552 to 1607. It is organized into two sections. In the first half of this chapter, I scrutinize colonial water management from

[1] The Spanish did not settle Mexico City immediately after defeating the Aztec in 1521. It took them and their Indian laborers three years to rebuild the conquered city. In 1524, Cortés and his men moved from their temporary mainland base of Coyoacán to the island.

1552 to 1604. This fifty-two year period is marked by two important shifts in Spanish flood control practices. In the opening pages of this chapter, I explain how and why the Iberians came to realization that their passive acceptance of pre-Columbian methods to regulate the ebb and flow of the lakes were no longer an option. This realization, I argue, did not stem from a preconceived concern for preventing inundations. Rather, in an ironic twist of fate, flooding brought about a new sensibility towards managing the lacustrine environment. Recognizing the eventual fate of the city if no flood plan were implemented, I show how and why the Spanish actively adopted the pre-Columbian hydraulic method after the floods of 1552 and 1553. No longer the passive inheritors of this network, the Spanish took to hydraulic tasks that resembled Aztec flood control, an illustration of their new hands-on approach to water management. This new approach to flooding marks the first important shift in Spanish hydraulic practices.

The adoption of this Indian method to regulate the lakes by the newcomers did not translate into its wholesale acceptance. While the Spanish turned to the existing hydraulic network to prevent disasters, we will study why they did not view this method as a long-term solution to the capital's flood problems. Doubting the ability of the causeways, dikes, and floodgates to safeguard the city meant that other methods to regulate the lakes would have to be considered. But what would be the character of a new approach, and upon what principles would it be founded? In our examination of the flood of 1555, I will demonstrate how this deluge begins a new phase in the history of Mexico City water management. In the midst of devastation, the idea of the *desagüe* was born. Drainage as a method to control flooding illuminates the second shift in colonial water management. Drainage was a novel idea for managing flooding, but more importantly, it was one viewed as inherently superior to the pre-Columbian system. Despite the colonial belief that drainage was better than regulation, we will consider how a

Spanish lifestyle changed the balance between the city and lakes and how this change made the Aztec hydraulic network less effective over time, and thus, the city more susceptible to flooding. Within this context of doubting the causeways and dikes, I situate the first *desagüe* proposals of the colonial period for our scrutiny.

In the fall of 1555, Ruy González and Francisco Gudiel, respectively, proposed drainage plans. Although these schemes were never implemented, we will analyze them for their commentary on how the Spanish colons conceived of drainage. More importantly to the subject at hand, the story of the *desagüe's* origins is not as straightforward. While studying Gudiel's proposal a historiographic conundrum will become evident. Was Gudiel solely a proponent of drainage as has been argued by desagüe scholars or was drainage part of a larger water management scheme? In my study of Gudiel's plan, I situate his drainage proposition within a broader understanding of Mexico City's water-related issues, namely, droughts, pestilence, and "resistance." In so doing, I redirect our understanding of the earliest form of the *desagüe* from solely being a drainage scheme to one that was part of a multi-layered approach, taking into consideration the importance of water to the city.

Following my analysis of Gudiel's proposal, I analyze two flood control schemes initiated by Viceroy Enrique de Velasco the Elder. The first, a plan proposed during the flood of 1555, outlined a series of hydraulic tasks that resembled Aztec flood control. We will study this plan for how it frames a colonial form of pre-Columbian water management. Yet what is most striking about the proposal is not the hydraulic assignments outlined, but rather how the scheme was received by the *cabildo*. Although the city council deemed the viceroy's plan as being *santa y buena* (holy and good), when asked to lend their financial and administrative support they did not view the project favorably. As a result of council's negative outlook on the scheme, we will explore the legal, financial, and social reasons for rejecting the plan. This political battle between the viceroy and *cabildo* highlights how colonial bureaucracy factored into flood control, even when the city was in its darkest hour.[2]

The viceroy's second attempt at flood control provides us with a different approach to inundations, namely, diversion. Three issues are important for us to consider. The first: even though the floodwaters of 1555 had receded and with no threat of flooding in sight, why did Viceroy Velasco not stand idle? In what can be considered the first colonial attempt to be proactive in preventing flooding, the viceroy initiated an investigation a into a flood control plan in the spring of 1556, months before the rainy season was to begin. The second issue of importance examines the character of Velasco's investigation. In a series of letters written to García de Valverde, the *corregidor* (governor) of Atengo, we find that the exploration circumvented the *cabildo*. Perhaps in response to the city council's refusal to support his initial scheme, the 1556 inquiry becomes the sole concern of Velasco and Valverde. The last point for consideration is the study of the scheme. Surprisingly, the letters make no mention of the hydraulic network. Instead, Velasco had begun a flood plan based on diverting the Cuautitlán River. While the shift from control and regulation in 1555 to drainage in 1556 is important, we will study how the viceroy's latter scheme was to work.

The concluding pages of this first half of this chapter examine the *desagüe* proposals associated with the inundations of 1580 and 1604, respectively. Here, I scrutinize these schemes to analyze how each proposed to end the age-old problem of flooding. However, as with

[2] Obtaining consensus when it came to flood control, a theme examined by Louisa Schell Hoberman in her 1974 essay "Bureaucracy and Disaster: Mexico City and the Flood of 1629." Although this article scrutinizes how colonial bureaucracy impeded agreement in 1629, it aids understanding why achieving consensus in 1555 was problematic. See Louisa Schell Hoberman, "Bureaucracy and Disaster: Mexico City and the Flood of 1629," *Journal of Latin American Studies* 6, no. 2 (Nov., 1974): 211-230.

previous drainage proposals, they were never implemented due to cost or because floodwaters had receded. By abandoning these *desagüe* plans, the colonial authorities returned the to Aztec hydraulic method to rebuild the damaged structures, making causeways wider and taller, and dredging canals, among other water-related tasks.

We can conceive of the years between 1555 and 1604 as a period of wavering between different models to control flooding: regulation, diversion, and drainage. Yet with the deluge of 1607, the Spanish were now committed to championing a single method. Viceroy Enrique de Velasco the Younger requested proposals for implementing drainage. Several schemes were offered and studied, but one in particular stands out: a project by the German cartographer Enrico Martínez. Constructed in a mere ten months, the *desagüe* had finally been realized. The relatively short time span to build the drainage scheme prompts a simple question: What changed in the minds of the colonial authorities to finally implement the desagüe? The answer to this question lies not only in understanding the technological aspects Martínez' plan, but equally as important, comprehending how the colonial authorities reimagined the problem of flooding. I draw attention to two points. The first highlights how the Spanish lost all faith in the Aztec hydraulic network to safeguard the city. After six floods in the span of fifty-two years, the Spanish were truly at their wits' end. In the midst of the 1607 inundation, they were now determined to build the *desagüe*. The second point examined within this changing mentality is how the cost of catastrophic inundation was understood. Until this point, the price of drainage by far outpaced that of reconstructing the old network. But in 1607 a new financial consideration was introduced that reshaped the nature of how drainage was conceived. Now any talk of disaster included the value of Mexico City and its buildings.

Within this new appraisal of catastrophe, the pendulum quickly swung in favor of the *desagüe*. While financial considerations are important for understanding why the *desagüe* was built, perhaps what is most striking about Martínez' work is not the drainage portion of his scheme. After all, he was not the first to propose a discharge plan, nor did he offer a new route by which the lakes would be delivered to the Gulf of Mexico. Rather, what is truly unique about Martínez' plan was the production of a map, *Descripción de la comarca de México i obra del desagüe de la laguna* of 1608. The making of maps to aid in previous drainage proposals was common practice. Unfortunately, the whereabouts of these graphic documents is unknown (if they have survived at all). Without these maps, we are unable to understand these former water management proposals in greater detail, leaving us with a gap in our understanding about the *desagüe* prior to 1607. With this cartographic lacuna in mind, it is surprising that historians of the *desagüe* have tacitly ignored Martínez' map. In short, the map has been treated as a mere illustration by scholars when writing on the drainage project. By shying away from *Descripción de la comarca de México i obra del desagüe de la laguna,* they have thus failed to interpret Martínez' visual commentary. As a result, our knowledge of how Martínez graphically conceived his project, the city, and the lakes has not been part of our understanding of the *desagüe* until now.

Colonial Flooding Begins

In 1552, Mexico City experienced its first colonial flood. Ruy González, a *regidor* and *maestro de obras públicas* (city council member and architect of public works) offered his opinion on the inundation.[3] Based on three projects under González' supervision, described in

[3] The earliest mention of Ruy González in the *actas de cabildo* occurred on March of 1525 when he requested a *solar* (building lot). See A. C., March 30, 1525. González was elected to the city council as an *alcalde ordinario* in

the *actas de cabido*, we can deduce that he had some experience dealing with water-related issues. In 1542, he worked on draining an *ejido* owned by the city.[4] That same year, he built a canal.[5] And, in 1547, he removed obstacles that interrupted the flow of the Tepeaquilla River.[6] Although these projects were minor in scope, González' ideas on how to end the 1552 flood were extensive.

On November 14, 1552, González proposed a multi-layered plan that encompassed a wide range of water-related activities.[7] Many of these activities resembled Aztec flood control in scope and character. For example, not unlike the pre-Columbians, he called for inspecting rivers, particularly, the Tepozotlán and Cuautitlán; for repairing dikes, canals, and roads; and for cleaning canals. Other recommendations included returning the city to its former aquatic environment. Case in point: he called for eliminating all new wells and canals and that the city's original waterways be returned to their "ancient" course. A third aspect of his plan was concerned with getting food to the city. He advised that all livestock be ushered into Mexico City via the *camino real* of Azcapotzalco, since the path normally taken was underwater. Strikingly, González' recommendations drew little attention from the colonial authorities.[8] We are unable to deduce if the receding waters influenced the authorities' outlook on the plan.

The following year, the city was inundated again.[9] The dike of San Lázaro, the last line of defense for protecting the island city, was damaged. If González' suggestions fell on deaf ears

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January 1533 (A. C., January 1, 1533). Cañeque defines *alcalde ordinario* as follows: "city magistrate, having jurisdiction in both civil and criminal cases." Refer to Alejandro Cañeque, *The King's Living Image: The Culture and Politics of Viceregal Power in Colonial Mexico* (New York: Routledge, 2004), 251.

[4] A. C., June 9, 1542.

[5] A. C., September 15, 1542.

[6] A. C., May 26, 1547.

[7] A. C., November 14, 1552.

[8] Mathes, "To Save a City," 425; Cepeda, Carrillo, and Serrano, *Relación universal*, 42.

[9] Cepeda, Carrillo, and Serrano, *Relación universal*, 42.

the year prior, in this case the dike was repaired within a matter of days.[10] One limitation in understanding these floods is the relative paucity of historical records that describe them. Although it is difficult to comprehend the extent of the damages to the city from the archival sources and the secondary literature consulted, two important points can be made about their impact. First, despite the lack of attention that González' plan received, we can consider this scheme as the first colonial step in reconsidering the city's relationship to the lakes. It marks a shift on the part of the Spanish from passively accepting the pre-Columbian flood control network prior to 1552 to embracing it, at least on a limited and selected basis. The second point to consider is the incidence of flooding. Until the flood of 1552, the colonial city had yet to experience an inundation, a period of nearly three decades since the city was founded. Two floods in back-to-back years should have been enough of a warning sign to alert the Spanish of the island's propensity to flood. Notwithstanding González' recommendations in 1552 and the rebuilding the dike of San Lázaro in 1553, a comprehensive water management plan was still not a significant concern for the colonial authorities. Regrettably, this inaction proved to be a serious lapse in judgment two years later when the city was once again underwater.

The Flood of 1555

On October 10,1555, a torrential downpour pummeled the Basin of Mexico.[11] The rainfall was brief, lasting less than twenty-four hours, but its effects were great. Four days later,

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[10] Mathes, "To Save a City," 425; Cepeda, Carrillo, Serrano, *Relación universal*, 42.

[11] Mathes, "To Save a City," 425; José Ignacio Rubio Mañé, *El Virreinato*, 2nd ed. (Mexico City: Instituto de Investigaciones Históricas, Universidad Nacional Autónoma de México and Fondo de Cultura Económica, 1983), 4:13; *Memoria histórica, técnica y administrativa de las obras del desagüe del valle de México, 1449-1900*, 1:59. A discrepancy exists as to the date of the flood. For example, Rubio Mañé offered that it occurred in October, but provided not date; Mathes suggested October 10; and in *Memoria histórica, técnica y administrativa*, September 17, 1555 is given. With respect to the latter, there is no mention of the flood in the *actas de cabildo* on this date or immediately after.

nearly all of Mexico City was underwater.[12] Unable to reach the mainland via carriage, horseback, or by foot, Spaniards were limited to canoes, a form of transportation used primarily by Indians.[13] Having suffered its third flood in a mere four years, the Spanish began to believe that the pre-Columbian flood control method was ineffective. However, the increase in flooding was not due to some inherent flaw in the Indian method to control and regulate the lakes. At the center of the diminished capacity of the causeways, dikes, and floodgates to withstand floodwaters was the behavior of the Spanish. Consider the following example: in preparation for the siege on Tenochtitlan, Cortés ordered breaches made in the dikes and causeways to allow for brigantines to enter the city.[14] After defeating the Aztec, these breaks in the hydraulic walls were never adequately repaired. By themselves these openings were not the sole cause of flooding in the 1550s, but they certainly contributed to it.

Compounding the hydraulic relationship between the city and the lakes was also a Spanish lifestyle. Several changes from a pre-Hispanic way of life to a European one deserve mention. As the first example of several, take the mule- and horse-drawn carriages favored by the Spanish. To make room for these animal-powered vehicles, city canals were eliminated.[15] Complicating matters, waterways were also filled in to accommodate the planning of the city.[16] As previously mentioned in my discussion of the *Uppsala Map*, canals were essential hydrographic elements for regulating water levels. Without them, the remaining canals were placed under additional strain to control the ebb and flow of Lake Mexico.

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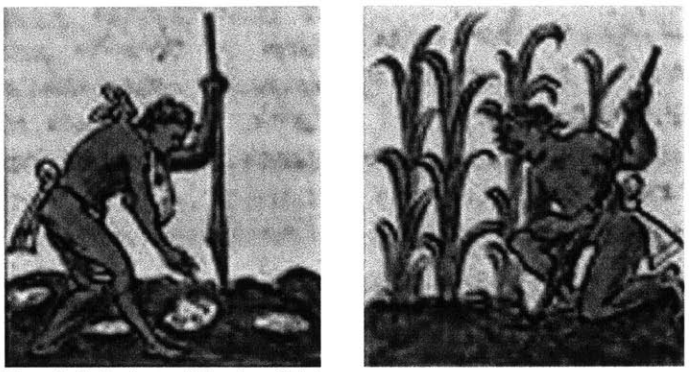
[12] A. C. October 11, 1555; Mañé, *El Virreinato*, 4:13; Mathes, "To Save a City," 425; and *Memoria histórica, técnica y administrativa*, 1:59.
[13] Mañé, *El Virreinato*, 4:13; Mathes, "To Save a City," 425; and *Memoria histórica, técnica y administrativa*, 1:59.
[14] Mathes, "To Save a City," 424.
[15] Mathes, "To Save a City," 425; Hoberman, "City Planning in Spanish Colonial Government," 25.
[16] Mathes, "To Save a City," 425; Hoberman, "City Planning in Spanish Colonial Government," 25. Although Gibson does not explicitly mention the filling of canals for the purposes of building the city, he does refer to eliminating them for the "maintenance of the capital." See Gibson, *The Aztecs Under Spanish* Rule, 221.



Figs. 1 & 2. Aztec Digging Stick.

A third example to negatively impact water levels was the introduction of European agricultural methods. To better understand the relationship between flooding and Spanish agriculture, let us briefly examine the pre-Columbian practice of food production. In Aztec times, a digging stick was the favored tool used for preparing the land for planting corn or other vegetables. In the vignettes drawn by a native artist for Sahágun's *Códice florentino* (*Florentine Codex*), we can easily comprehend how this stick was employed in maize cultivation (Figs. 1 & 2).[17] The digging stick consisted of a long handle with a sharp, elongated edge. Planters would use the stick to create a small opening in the earth where corn kernels could be deposited. As we can deduce from a simple observation of the second image, maintaining the crop depended on using this tool to remove unwanted weeds. Despite the fact that employing a digging stick was labor intensive, it kept disruption of the topsoil to a minimum. In turn, when the summer rains came, little of this loose soil would be washed into the lakes, thus keeping silting to a minimum.[18]

On the other hand, the Spanish preferred the plough for crop cultivation. Plowing had a greater impact on soil disruption than the digging stick. A plough, pulled by a team of draught horses or mules, cuts deeper and wider into the earth than the pre-Columbian stick ever could.

[17] Bernardino de Sahagún, *Códice florentino*, 3 vols (Mexico City: Secretaría de Gobernación, 1979).

[18] This is not to suggest that silting was not an issue in pre-Columbian times.

While plowing brings nutrients to the surface and aerates the soil, thus aiding in the cultivation of crops, it disturbs the topsoil considerably. To further emphasize the issue of soil disruption in colonial times, the introduction of cloven-hooved animals, such as sheep and cattle (animals not known in the pre-Columbian world), and the cutting down of trees to build Spanish homes, furniture, and carriages, added to the process of soil erosion. With the region's topsoil disturbed to a greater extent, annual rainfall would have a bigger impact on the balance between the city and lakes. During the rainy season, this loose soil would be washed downward into the lakes, silting them. In turn, the silt raised the lakes' levels, putting the city at a greater risk of flooding. Examined singularly, the changes introduced by the Spanish may not have been the determining factor for an increase in flooding, but when considered collectively, they demonstrate how colonial ideas about land use adversely affected the basin's natural environment. Thus, we can conceive how colonial flooding was not only a problem of excess rainfall, but also one that was intertwined with a Spanish lifestyle. With this last point in mind, Spanish practices strained the existing hydraulic network in a manner that was never accounted for in the planning, engineering, and construction of these water-related structures by the pre-Columbians.

Two weeks after the rainstorm, Mexico City was still underwater. On October 25, Viceroy Velasco and the city council convened to discuss the matter.[19] They noted that the floodwaters had not yet begun to recede, but were still on the rise. The colonial authorities could no longer wait for the day that floodwaters retreated on their own as they had done with the two previous inundations. Immediate action was required. The Spanish administrators commissioned

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[19] Mañé, *El Virreinato*, 4:13; Mathes, "To Save a City," 425. Velasco (1511-July 31, 1564) arrived in New Spain in 1550 as its second viceroy. In 1553, he established the first university in the New World, the *Real y Pontificia Universidad*. See Humberto Mussachio, Diccionario enciclopédico de México (Mexico City: Andrés León, 1989), 4:2139. According to *Memoria histórica, técnica y administrativa*, this meting occurred on October 23, 1555 (1:59).

a study to bring the flood to an end.[20] The *procurador mayor* and alderman Geronimo Rruyz [sic] was assigned this important task.[21] He was charged with assessing flood-related damages, examining how to undertake repairs, and asked to offer recommendations for ending the deluge.[22] An Indian-made map of the city was provided to aid his investigation.[23] Unfortunately, the location of this map is unknown if it even exists today. Given the importance of his assignment, Rruyz wasted no time in completing his task. On October 30, he presented his findings, calling for the opening of floodgates and the closing of others, for returning rivers to their former paths, and for repairing dikes and causeways.[24]

The measures proposed by Rruyz are significant. Like González before, they represent a range of hydraulic activities not previously untaken by the Spanish.[25] The activities called for by Ryuiz, at the very minimum, suggest a newfound recognition for importance of the city's hydraulic network. The adoption of an Indian flood control method is not surprising, as it was the only immediate option available to the Spanish. However, it was not the only course of action considered. Many doubted the ability of the causeways, dikes, and floodgates to keep the city safe. Having reservations about the existing hydraulic network meant that a new approach would have to be considered. In the midst of catastrophic inundation, the idea of the *desagüe* was born.[26]

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[20] A. C., October 25, 1555.
[21] A. C., October 14, 1555.
[22] *Ibid.*
[23] Mañé, *El Virreinato*, 4:14; Mathes, "To Save a City," 425.
[24] To be more specific, Rruyz called for repairing and closing the floodgates in the *calzada de Guadalupe*; for closing of gates in the *calzada de Tacuba-Tlatelolco*; for opening the floodgates in the *calzada de Iztapalapa*; for diverting water to the Chapultepec canal and to an area near Azcapotzalco; for returning the Coyoacán and Tacubaya rivers to Lake Texcoco; for rebuilding the dike of San Lázaro; for eliminating several city canals (to prevent water from entering the capital); and for repairing the causeways leading from the island. See Mathes, "To Save a City," 425; and *Memoria histórica, técnica y administrativa*, 1:59-61.
[25] Not even González' 1552 offerings were as detailed.
[26] Candiani, "Draining the Basin of Mexico," 5.

The Origins of the *Desagüe*

On Tuesday, November 26, 1555, Ruy González and Francisco Gudiel, respectively, presented alternative *desagüe* plans.[27] In a very brief proposal, González called for the lakes and rivers of Citlaltepec, Cuahutitlán, Zumpango, Ecatecpec, Chiconautla, and Tecama to be prevented from entering Lake Mexico, and thus, by extension, the city.[28] At first glance, González' proposal appears to be a plan based on diverting water. However, it was not. The city council minutes of November 29, 1555 note that this rechanneling of water was part of a drainage strategy.[29] González provided the *cabildo* with a written proposal and a map of his scheme for their consideration.[30] Regrettably, the location of the proposal is unknown and the minutes fail to provide a description of the plan, how it would have worked, or the path it would have taken. The minutes do, however, indicate that the map identified González' course of action, but like the whereabouts of the proposal, the location of this map is not known.

On the other hand, a record of Francisco Gudiel's proposition is readily accessible for our scrutiny. In a two-and-half page *memoria* (report) entered into the city council minutes, and later published (in 1976) as "Memoria de Francisco Gudiel, año de 1555," we learn about his ideas for water management.[31] A long-term *vecino* (resident of the city), he began his proposal by highlighting his hydraulic abilities—the knowledge to weigh and measure water—and his understanding of the basin's geographical terrain.[32] In preparation for writing the *memoria*, Gudiel undertook an empirical study of the flood, lakes, and rivers, surveying more than seventy

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[27] Mathes, "To Save a City," 426; *Memoria histórica, técnica y administrativa*, 1:63.
[28] A. C. November 26, 1555; Francisco Gudiel, "Memoria de Francisco Gudiel, año de 1555," in *Obras públicas en México*, 3:13.
[29] A. C. November 29, 1555; Gudiel, "Memoria de Francisco Gudiel, año de 1555," 3:23.
[30] A. C. November 29, 1555; Gudiel, "Memoria de Francisco Gudiel," 3:23. González' strategy was published with Gudiel's plan.
[31] Gudiel, "Memoria de Francisco Gudiel," 3:13-25.
[32] *Ibid.*, 3:15.

leagues.[33] But upon reading his report, we encounter a historiographic problem. *Desagüe* historians have painted Gudiel as proponent of drainage. While this point is true to a certain extent, his proposal requires re-assessment. Scrutinizing the plan reveals a more intricate idea of water management than one based solely on drainage. Indeed, the *desagüe's* origins are more complex than we have been led to believe. Before we examine how Gudiel conceived of drainage, let us first study aspects of his plan not readily considered when attributing the *desagüe* to Gudiel.

Point two of the proposal shows that Gudiel conceived of water beneficial as well as problematic. In fact, he emphasized the need to maintain a healthy supply for the benefit of the city, arguing that water was an essential component to how it functioned. Importantly, he considered the way the city's relationship to lakes went far beyond the single concern of flooding, accounting for the city's other water-related issue, namely, droughts pestilence, and "resistance." Yes, Mexico City also suffered from the scarcity of water, a topic overshadowed by the city's flood problems. In her dissertation, "Fervent Faith: Devotion, Aesthetics, and Society in the Cult of Our Lady of Remedios (Mexico City, 1520-1811)," art historian Rosario Inés Granados Salinas has identified how the cult statue of Remedios was brought in procession from Totoltepec Hill (on the mainland) to Mexico City during times of droughts to end the calamity.[34]

Clearly, droughts presented another kind of catastrophe that also required resolution. For Gudiel, droughts were also a source of foul odors that overwhelmed the city's inhabitants. While unwanted smell was indeed a nuisance, pungent odor alone was not the root of his concern. Rather, stench "engendered pestilence" in Gudiel's reasoning, which would ultimately cause the

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[33] *Ibid.* According to Genotte, a league (of Castile) consists of 5,572 meters. See Jean François Genotte, "The Mapa de Otumba," *Ancient Mesoamerica* 12, no. 1 (Jan., 2001), 134.

[34] Rosario Inés Granados Salinas, "Fervent Faith: Devotion, Aesthetics, and Society in the Cult of Our Lady of Remedios (Mexico City, 1520-1811)" (PhD diss., Harvard University, 2012).

death of many.[35] The only solution for preventing pungent smell associated with low water levels was for the lakes to be full.[36] Gudiel's concern for the city having the water it required demands *desagüe* scholars to rethink the early beginnings of drainage at Mexico City. While it does not change the fact that Gudiel's plan offered drainage as a flood control solution, the proposal demonstrate thoughtfulness to Mexico City's other water-related issues rather than only flooding.

Interestingly, Gudiel's recognition of the importance of water did not engender a vote of confidence for the Aztec hydraulic network. Point five of his proposal makes us aware of his stance on the city's hydraulic elements. Although they aided in the defense of the city, he wrote, they could never be a long-term solution to flooding. Gudiel conceived the hydraulic network as only providing "resistance" (*resistencia* in Spanish). This term, as employed by Gudiel, describes the holding back of floodwaters by hydraulic structures. An analogous example is how a retaining wall holds back a hill or a berm. In both instances, a constant pressure is applied to the structural element. Gudiel's criticism of *resistencia* thus illuminates an important shortcoming of the hydraulic network: how to relieve the non-stop force against these structures in times of high water. A method for alleviating this pressure was never devised by the Aztec. Simply put, the function of the network was to keep floodwater from entering the city. Even if successful, the capital was still not free from harm. As *desagüe* historian Louisa Schell Hoberman has noted, with no method to relieve this pressure, the city's inhabitants would have to wait out the flood.[37] Waiting for the waters to recede could take weeks, months, or as in the disastrous case of the 1629 flood, years. Patience was a strategy employed by the Aztec, but Gudiel's remarks signal that this was not an option for the Spanish.

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35 Gudiel, "Memoria de Francisco Gudiel," 3:15.

36 A detailed analysis of the relationship between odors, pestilence, and drought is lacking from any study on the *desagüe*.

37 Hoberman, "Technological Change in a Traditional Society," 402.

In the following sections of the proposal, Gudiel further outlined his approach towards water management. Importantly, they account for how he would prevent drought, pestilence, *resistencia*, while simultaneously providing the city with an ample supply of water. Gudiel correctly deduced that the Cuautitlán River was the cause of inundations. He declared that the only method for saving the viceregal capital was to divert the river northward to the town of Huehuetoca via a canal two leagues in length and sixty feet wide. Once at Huehuetoca, Gudiel proposed that natural crevices in the northern mountains would allow the water to exit the basin.[38] With the water on the exterior side of the basin, according to the scheme, it would follow the natural terrain downward to the Tepexeque, a tributary of the Tula River. In turn, the Tula flowed towards the Panuco River, which eventually made its way to the Gulf of Mexico.

Drainage as a flood control solution was innovative. It departed from any of the pre-Columbian undertakings. But recall that inundation was just one of four issues that concerned Gudiel. Let us now turn to how his plan handled the problems of drought, pestilence, and "resistance." Perhaps ironically, Gudiel called for a series of floodgates of his own. After criticizing hydraulic structures as a short-term solution to inundation, a plan incorporating these devices appears odd. One would imagine that his plan would have precluded any hydraulic device resembling Aztec ones. However, floodgates, according to Gudiel's logic, were not to be rejected if their function served a different purpose. Instead of shielding the city from floodwaters, as those employed by the Aztec, floodgates would keep water within the city's limits. This idea appears to be counterintuitive to drainage. Here, we must be mindful that Gudiel conceived of flooding as a part of a much larger issue of water management. In Gudiel's reasoning, the expulsion of water and maintaining it withnin the city were not diametrically

[38] Hoberman pointed out that Gudiel's plan did not address the problem of discharging water through the northern mountains without the aid of a tunnel. See "City Planning in Spanish Colonial Government," 51. Without the aid of a tunnel, natural crevices left to chance the efficiency and ultimately, the success of drainage.

opposed. As we can now begin to understand, water was never the core issue of flooding for Gudiel. Rather, it was its excess.

Key to providing the capital with the water it required were floodgates. Strategically located, these gates were to be constructed at the end of the yet-to-be constructed canal at Huehuetoca (and also at the San Cristóbal River). These hydraulic devices, not unlike those of pre-Columbian origin, would regulate the flow of water, but with one significant difference. Aztec floodgates shielded the city from floodwaters. But, in marked contrast, Gudiel's floodgates were to keep water in the basin for the benefit of the city and its inhabitants. The Spaniard's gates were to function on the simple premise that when flooding was imminent, they would be opened, allowing water to exit the basin via the human-made canal and natural crevices of the mountains.

Gudiel also accounted for the problem of drought with these gates. Floodgates were to aid in fending off catastrophes (or significantly limiting their impact). For example, when a drought was upon the city, the gates would be closed, allowing for the much-needed water to return to its natural course, eventually reaching the lower-lying city. In turn, with the lake levels safely maintained, foul odors would be avoided, and thus *pestilence* would be deterred. Yet, in spite of the multi-dimensional character of the scheme, it could not regulate all aspects of the natural environment. Regardless of their placement, as either part of a dike or drainage canal, floodgates could not wholly remedy droughts. Simply put, no floodgate could replenish the lakes forever. Without rain, eventually they would stand idle.

Lastly, let us consider how Gudiel proposed to avoid the issue of "resistance," his main criticism of the Aztec network. As previously described, these structures were forced to withstand the pressure applied to them by floodwaters. If rushing waters compromised these structures, the city would flood. If they withstood the initial onslaught, but if the waters crested, the city would also be inundated. A flooded city was not acceptable. To the surprise of no one, nowhere in the *memoria* does Gudiel call for reinforcing Aztec structures. If flooding were imminent, Gudiel's gates would be opened, allowing the excess water to flow freely, and thus, avoiding the problem of "resistance." The implications of Gudiel's plan are clear: a multi-dimensional scheme, that included drainage, was required to overcome Mexico City's susceptibility to flooding.

It is difficult to judge if Gudiel's plan would have worked. We do not know enough about the region's topography in 1555 to gauge whether the crevices that Gudiel mentioned in his scheme were sufficiently large to allow water to exit from the basin in the amount required to prevent flooding. Perhaps most telling as to the feasibility of Gudiel's strategy, in particular the use of crevices, is that later *desagüe* proposals never mentioned these as a method to expel water from the basin. A few last points about Gudiel's proposal deserve attention. Along with his report, Gudiel also provided a map (made on parchment).[39] As with González' map, its location is unknown. Gudiel concluded his *memoria* by stating that, with the aid of 100,000 Indian workers, his plan could be operational before the start of the next rainy season.[40] On November 29, 1555, the *regidor* Alonso de Mérida and treasurer Hernando de Portugal were tasked with assessing the feasibility of Gudiel's plan.[41] On December 16, 1555, Mérida and Portugal gave drainage a favorable review.[42]

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[39] Gudiel, "Memoria de Francisco Gudiel," 3:23; *Memoria histórica, técnica y administrativa*, 1:67

[40] Gudiel, "Memoria de Francisco Gudiel," 3:18; Mathes, "To Save a City," 426; and *Memoria histórica, técnica y administrativa*, 1:66.

[41] A. C., December 16, 1555; Mathes, "To Save a City," 426; Gudiel, "Memoria de Francisco Gudiel," 3:22. González' drainage plan was also studied at this time.

[42] Mathes, "To Save a City," 426; *Memoria histórica, técnica y administrativa*, 1:67. Merida and Portugal also provided a map of their own (on cloth) to aid understanding their findings. Like previously mentioned maps, its whereabouts are not known.

Gudiel's scheme puts us at the center of a historiographical conundrum. Historians have conceived Gudiel's plan only in terms of drainage. Yet his proposal clearly demonstrates that although he was a proponent of drainage, he also made the case for the viceregal capital to have the water it required. For Gudiel, there was no incommensurability between drainage and the aquatic needs of the city. As we will see shortly, future *desagüe* proponents were unconcerned with this relationship. Ultimately, Gudiel's proposal demonstrates how the origins of the *desagüe* were part of a larger plan of water management, a point that until now *desagüe* scholars have yet to make.

The importance of Gonzâlez' and Gudiel's respective schemes, for the purposes of this dissertation, does not rest on their intended success. Rather, their significance is based on being the first proposals that introduced drainage as a flood control method. These schemes signal the second shift in Spanish colonial water management. Recall that, prior to the flood of 1550, the colonial authorities were relatively unconcerned the possibility of inundations. Once the city flooded in 1552, they turned to the "old" hydraulic network for safety, highlighting the first shift in colonial flood control practices. However, when the city suffered its third inundation in four years, an entirely new idea about how to manage the lakes emerged from catastrophe. Gonzâlez' and Gudiel's drainage schemes were considered but they were not implemented. As historian of the *desagüe* W. Michael Mathes has argued, any hope for executing a drainage plan was lost when the plans were tabled as too costly.[43]

[43] Mathes, "To Save a City," 426.

Drainage, Diversion, or Dikes

By foregoing any *desagüe* plan, the viceregal authorities were left with only one option: to return to the pre-Columbian method of flood control. While González' and Gudiel's proposals were being studied, Viceroy Velasco was already attending to how to reconstruct the dikes, causeways, and other flood-related structures. In a letter penned in the city of Toluca, on November 3, 1555, he outlined a plan.[44] It resembled pre-Columbian hydraulic practices. Case in point: similar to the pre-Hispanic custom employed in hydraulic tasks, the nearby indigenous communities were to be a source for labor. In this instance, Velasco directed that the four Indian *cabeceras* of Mexico, Tacuba, Chalco, and Texcoco provide a total of 6,000 Indian laborers.[45] This army of workers was required to assemble in Mexico City the following month (on December 1). Their task, as in "ancient" times was to repair the causeways and dikes. Work on rebuilding the dike of San Lázaro, for example, was to begin on December 6. Reconstructing this structure alone was a monumental task. As previously noted, this dike protected the island's eastern shoreline, being the city's last line of defense from any encroaching waters. Its importance to the city can also be understood by its physical size. It measured nearly 6 *varas* (16.5 feet) in width and stretched for more than 9,000 *varas* (4.68 miles) between the causeways of Guadalupe and Iztapalapa.[46] Repairs were estimated to take no more than two months. By order of Velasco, the city council was to lend their support for the project. First, they were required to provide the tools necessary to undertake reconstruction of the damaged hydraulic

[44] Archivo Histórico de la Ciudad de México (hereafter AHCM), Desagüe: vol, 2152, November 6, 1555; Mañé, *El Virreinato*, 4:13-14; and A. C., November 6, 1555.
[45] AHCM, Desagüe: vol, 2152, November 6, 1555; Mañé, *El Virreinato*, 4:13-14; and A. C., November 6, 1555. Gibson has claimed that this labor force totaled at least two million and not six thousand (*The Aztecs Under Spanish Rule*, 225)
[46] Cepeda, Carrillo, and Serrano, *Relación universal*, 40; Gibson, *The Aztecs Under Spanish Rule*, 225. Gibson gives 20 feet as the width of the dike and just shy of four miles as its length. The *vara* was the Spanish unit of distance. It was equal to 83.8 centimeters.

structures.[47] Second, the council was to provide the food necessary to feed this army of workers.[48] Each Indian worker, according to Velasco letter, was to be given a *cuartilla* of maize and one pound of meat per day.[49]

On November 11, the city council responded in writing to the viceroy's requests.[50] It offered several reasons why it could not support the plan. The *cabildo* claimed it could not allocate the food outlined in Velasco's letter. Not unlike how the viceroy called upon the pre-Columbian practice of tribute labor in the wake of catastrophic flooding, the *cabildo* also referred to an "ancient" practice in their rebuttal: Indian workers provided their own food when assigned hydraulic tasks.[51] This type of exchange between the viceroy and *cabildo* is an interesting one. Both looked to Indian antiquity to support their respective claims. However, the council's use of this pre-conquest custom had less to do with "tradition" and more to do with economics. Simply put, it did not want to participate in a scheme that required a financial outlay on their part. This reasoning also extended to the tools called for by the viceroy. In very simple language, the council argued that their expense was burdensome.

With these financial concerns in mind, we can easily deduce that the city council wanted to limit their economic exposure to Velasco's scheme. To further reduce their participation, the *cabildo* also employed a legal tactic in their rebuttal. They reminded the viceroy that the council no longer had the authority to conscript unrecompensed Indians for their labor, a practice

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[47] AHCM, Desagüe: vol, 2152, November 6, 1555.

[48] AHCM, Desague: vol, 2152, November 6, 1555; Mañé, *El Virreinato*, 4:14; Mathes, "To Save a City," 426; and *Memoria histórica, técnica y administrativa*, 1:61.

[49] In total, 8,000 *cuartillas* of maize were called for Velasco. See Mañé, *El Virreinato*, 4:14; Mathes, "To Save a City," 426; and *Memoria histórica, técnica y administrativa*, 1:61. A *cuartilla* equaled one-fourth of a kilogram or just over half a pound. See Alfonso Villas Rojas' conversion table in *Estudios etnológicos: los mayas* (Mexico City: Universidad Nacional Autónoma de México, 1985), 403.

[50] A. C., November 11, 1555; Mañé, *El Virreinato*, 4:14-15; and Mathes, "To Save a City," 426.

[51] See also Gibson's description of the pre-Columbian practice of Indian workers providing their own sustenance (*The Aztecs Under Spanish Rule*, 220).

prohibited by royal ordinance in 1549, which the had council condemned when it was issued.[52] The intention of the monarchial decree was to create an Indian labor force free from Spanish coercion. The crown sought to establish a working force that was "free to choose its own tasks" in the belief that "coercion was unnecessary," if workers were adequately compensated for their work.[53] Indian labor was central to the construction activities in New Spain, and in particular, Mexico City. As art historian George Kubler noted in "Architects and Builders in Mexico: 1521-1550," Indians were the "real workers" of Spanish building projects.[54] Thus, without the labor of indigenous peoples, no building, road, or even flood control structure could be built.

The council offered one last point for refusing to support the viceroy's plan. As if the previous reasons were not enough to convey their dissatisfaction, the council argued that it bore no obligation to back the scheme, arguing it was not responsible for damages caused by the inundation. This last point requires explanation. Mexico City was a settlement that lacked the means to provide for its inhabitants and all their many needs. Take, for example, that fresh water had to be channeled into the city via an aqueduct from the mainland. In another case, part of the city's food supply had to be canoed from the *chinampas* in the southern lakes. In yet a third example of the settlement's inability to be self-sufficient, it lacked the means to provide the building materials it required to construct civic and private structures. With no quarries or forests on the island, materials had to be carried over the causeways or canoed from the mainland. The cost, time, and effort to haul stone and logs for miles would have certainly been great. Yet, nearby stood a ready source for stone.

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[52] *Ibid.*, 223.
[53] *Ibid.*
[54] George Kubler, "Architects and Builders in Mexico: 1521-1550," *Journal of the Warburg and Courtauld Institutes* 7 (1944), 10.

To circumvent the island's scarcity of stone, a shortsighted practice had developed. The neighboring dikes and causeways became a source for stone, thus saving the expense and effort to haul the heavy material from the mainland.[55] Pillaging hydraulic structures was an unwise choice that further put the island at risk of inundation. The removal of stone from hydraulic structures would have had a detrimental impact on their structural integrity, compromising their ability to withstand the force of floodwaters. It is a point that reinforces Gudiel's criticism of resistance and yet is another example of how the hydraulic network was weakened by Spanish practices.

But what did the city council really think of Velasco's plan? Given the city council's unwillingness to aid the viceroy, one could easily imagine a scenario where the *cabildo's* members disapproved of the scheme on its technical merits. However, this was not the case. In spite of the council's dissatisfaction with the plan, nowhere in the *cabildo's* response do we find criticism or disagreement with its technical framework. Quite to the contrary: the city council praised the scheme as being "holy and good" (*santa y buena*). Praising and rejecting the plan simultaneously brings to the forefront just how complex gaining consensus was in the early colonial period, even when the city was in its darkest hours. The incommensurability between these two arms of local government begins to illuminate the importance of political agreement in flood control. The inability to achieve bureaucratic consensus proved to be just as damaging to Mexico City as the water that flooded it. In "Bureaucracy and Disaster: Mexico City and the Flood of 1629," Hoberman calls attention to the many informal and formal conflicts between the colonial authorities in matters of flood control.[56] These conflicts, as she poignantly demonstrates,

[55] Indeed, stone used at the capital came from far away. In but one example, it was quarried in Oaxtepec, some sixty miles from the island. Kubler, *Mexican Architecture of the Sixteenth Century*, 1:83.
[56] Hoberman, "Bureaucracy and Disaster," 211-230.

proved to be obstacles too great to overcome, creating stalemates, and ultimately, putting to "rest the view that city government was a cooperative venture."[57]

The Velasco-Valverde Project

In January 1556, the flood finally ended.[58] While the waters had receded, concern for future inundations was strong. Fear of another deluge weighed heavily on Viceroy Velasco for him to stand idle. Despite the fact that the city council refused to lend their support the year prior, it did not deter him from initiating a flood control study of his own. In the spring of 1556, he commissioned an investigation to divert the Cuautitlán River. Diversion was a new approach to control flooding and a noticeable difference from Velasco's scheme the previous year. We can interpret Velasco's shift in one of two ways. On the one hand, he believed in the method of regulation but changed his mind after the flood had ended. Or, on the other, he may have always viewed regulation with skepticism, but while in the midst of flooding, it offered the only solution technologically in place and familiar to the workers who would implement it. Regardless of the reason for this shift, once the city was free from harm, the viceroy had the opportunity to investigate a new strategy.

On May 26, 1556, Velasco wrote to García de Valverde, the *corregidor* of Atengo.[59] Anxiety about a potential flood in the summer is clearly evident in Velasco's letter. The viceroy directed Valverde to devise a plan for diverting the river, a task he required to be completed

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[57] *Ibid.*, 229.
[58] Musset, "El Siglo de Oro del Desagüe de México," 58.
[59] Cepeda, Carrillo, Serrano, *Relación universal*, 43. Mathes, "To Save a City," 427; and *Memoria histórica, técnica y administrativa*, 1:69-70; José Fernando Ramírez, *Memoria acerca de las obras e inundaciones en la ciudad de México* (Mexico City: Secretaría de Educacíon Pública / Instituto Nacional de Antropología e Historia, 1976), 48-49. Along with the diversion of the river, the spring of Azumba was to be drained and the bridge at Ecatepec to be eliminated. Indian labor was to be employed in achieving these hydraulic tasks and it was not to come from a distance greater than three leagues.

before the start of the summer rains. Within two weeks after writing Valverde, the viceroy followed with a second message (dated June 3, 1556).[60] From this second letter, we learn that Valverde has already informed the viceroy about his preliminary findings. We are at a loss to what these early conclusions entailed since the location of the *corregidor's* response is unknown. In the second communiqué, Velasco instructed Valverde that diverting the river should occur in several places. Technologically speaking, multiple paths would allow for more water to be expelled than by just employing a single canal. Equally as significant, several paths would also allow for continuous discharge if one required cleaning or maintenance. Perhaps not surprisingly, the viceroy's anxiety about the upcoming rainy season is also detectable in his second letter. Case in point: he directed Valverde to divert the river regardless of the consequences. To aid the governor in completing his task in a timely manner, a map accompanied the viceroy's letter.[61]

Three days later (on June 6, 1556), Velasco wrote Valverde a third time.[62] From the letter, we can glean that the *corregidor* had already decided on a course of action. He had chosen a discharge path that began at Xaltoca, a location that was, the viceroy declared, not his first choice. Velasco preferred Teoloyuca, which in his opinion did not require a dam to be constructed. However, with the project already underway, Velasco reluctantly accepted Valverde's site selection. The *corregidor's* choice was not without conflict. Diverting the Cuautitlán River was a job for hydraulic technology, but the rechanneling of water also had social implications. Valverde's decision required a dam to be built. In the opinion of the Xaltocans, the dam would flood their agricultural fields, preventing them from cultivating their crops, and thus posing a serious risk to their very existence. Refusing to stand idle, this

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[60] Cepeda, Carrillo, and Serrano, *Relación universal*, 43-44.
[61] *Ibid.*, 43. As is the case with the previously mentioned maps, the whereabouts of this map is not known.
[62] *Ibid.*, 44-45.

indigenous community protested directly to Velasco, accusing him of lacking the authority to commission the project. However, if the viceroy's second letter to Valverde is any indication of how important he viewed diverting the river, then we will already know Velasco's response to the Indians' complaint. Despite instructing Valverde to minimize disruptions to indigenous communities in his first letter, this order did not supersede the safety of the viceregal capital. For Velasco, the loss of the Xaltocan fields was a necessary evil if Mexico City could be saved from inundation. This is the last we know of the Velasco-Valverde project from the correspondence between the two men. But if future *desagüe* proposals are any indication of the success of the Velasco-Valverde project, then we already know that it did not achieve its intended result.

The Flood of 1580

Velasco's tenure as viceroy ended on July 31, 1564 with his passing.[63] While his successors attended to the matters of the viceroyalty, any serious consideration for a comprehensive water management plan was by now a distant memory. For the next twenty-five years (after the 1555 flood), the citizens of Mexico City went about their everyday lives free from inundation. Despite this period of relative calm, it could not last forever. The city's susceptibility to flooding would make sure that one day the lakes would rise again to inundate the capital. In January 1580, Mexico City was again facing raging currents.[64] With the city inundated, the sitting viceroy Martín Enríquez de Almanza was pressed into action. Enríquez attacked the deluge in a two-part manner. Like Velasco before him, Enríquez turned to Aztec flood control methods to mitigate any further damage to the city. He ordered the fortification of

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[63] Mussachio, Diccionario enciclopédico de México, 4:2139.
[64] Mathes, "To Save a City," 427; A. C., January 18, 1580.

dikes, the raising of causeways, and the dredging of rivers.[65] The second part of the viceroy's plan centered on resurrecting the *desagüe.* Perhaps aware of the difficulties that Velasco had encountered with the city council in the 1550s, he did not attempt to impose a scheme upon them. Yet he could not implement drainage alone. He required the support of the *cabildo.* In an act of building consensus, on January 18, 1580, the viceroy met with *cabildo* member, *corregidor* Lorenzo Sánchez de Obregón to request his assistance with the council; Obregón was to make a case for the *desagüe* before his fellow city council members.[66]

The *cabildo's* minutes (of the same date) identify two overarching concerns. First, we learn that the floodwater had not yet receded. Second, the origin of the flood was a mystery to all.[67] To find the source of the inundation and to study the feasibility of drainage, the *cabildo* formed a commission under the supervision of *regidores* Antonio de Carvajal and Balthasar Mejía Salmerón.[68] The council also called for a team of *yndios antiguos* (Indian elders) to aid Carvajal and Salmerón with their investigation. The task of these native men was to impart their knowledge of the basin, its waterways, and flooding.[69] The Spanish architect Claudio de Arciniega and the engineer and royal cosmographer Francisco Domínguez were also part of the investigative party.[70] As with previous flood control proposals and investigations, a map was to

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65 Cepeda, Carrillo, and Serrano, *Relación universal*, 47.
66 Mathes, "To Save a City," 427.
67 A. C., January 18, 1580.
68 *Ibid.* See also Mathes, "To Save a City," 427; *Memoria histórica, técnica y administrativa*, 1:72-73.
69 A. C., January 18, 1580; Hoberman, "City Planning in Spanish Colonial Government," 52.
70 Mathes, "To Save a City," 427; *Memoria histórica, técnica y administrativa*, 1:73. The architectural projects of Arciniega are well known, particularly his commission of Mexico City's cathedral. This work and other projects are described in Manuel Toussaint, *Claudio de Arciniega: arquitecto de la Nueva España* (Mexico City: Universidad Nacional Autónoma de México, 1981) and in Luis Javier Cuesta Hernández, *Arquitectura del Renacimiento en Nueva España: "Claudio de Arciniega, maestro maior de la obra de la Yglesia de esta Ciudad de México"* (Mexico City: Universidad Iberoamericana, 2009).

play a role in the quest to end catastrophic inundation.[71] But as with other maps, the location of this document is a mystery. The party set out to survey the region north of the lakes. They took measurements at the molinos de Ontiveros, Huehuetoca, Nochistongo, and the Tula River.[72] On February 5, 1580, the commission presented a plan authored by Arciniega to the *cabildo.*[73] Drainage, they claimed, was the best hope for saving the city. Arciniega called for discharging water northward to the mountains, a scheme that Hoberman noted followed a similar path as Gudiel's plan two and a half decades earlier.[74]

Perhaps not surprisingly, not all in the investigative party were in agreement with Arciniega. Domínguez was overwhelmingly critical of drainage, taking his concerns directly to the Spanish monarch Philip II. From an excerpt of his letter to the king (published in 1902 in *Memoria histórica, técnica y administrativa*), we learn that Domínguez' reservations about a *desagüe* rested on three concerns: cost, feasibility of the project, and the negative impact on Indian workers.[75] Not dissimilar with the drainage proposals of 1555, the cost of the Arciniega's project was a factor. Estimated at 200,000 ducats (approximately 240,000 *pesos*), Domínguez believed it to be an excessive amount for a plan that would never achieve its objective given the engineering difficulties.[76]

A key point to make at this moment is that *drainage* via a tunnel was technologically a unique idea. While both the Aztec and Europeans used drainage canals to control flooding, the

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[71] A. C., January 18, 1580; Mañé, *El Virreinato*, 4:16; Mathes, "To Save a City," 427; and *Memoria histórica, técnica y administrativa*, 1:72-73.
[72] Cepeda, Carrillo, and Serrano, *Relación universal*, 47.
[73] A. C., January 18, 1580; Mañé, *El Virreinato*, 4:16; Mathes, "To Save a City," 427; *Memoria histórica, técnica y administrativa*, 1:73; Hoberman, "City Planning in Spanish Colonial Government," 52.
[74] Hoberman, "City Planning in Spanish Colonial Government," 52. The whereabouts of Arciniega's proposal is also unknown.
[75] *Memoria histórica, técnica y administrativa*, 1:73-74.
[76] I have converted ducats to *pesos* by using Boyajian's conversion table. See James C. Boyajian, *Portuguese Trade in Asia under the Habsburg, 1580-1640* (Baltimore: Johns Hopkins University Press, 1993), xvii.

mountains surrounding Mexico City posed a technological problem.[77] A tunnel miles-long anywhere in the world would have been an engineering marvel at this time. To understand this point in greater context, let us briefly examine the history of European drainage tunnels since pre-Columbian peoples never built one. Simply put, drainage tunnels in early modern Europe did not exist. It was not until the late seventeenth century, when the French built the Languedoc Canal in southern France, that a drainage tunnel was constructed. Only a tenth of a mile length, it was a far cry from the nearly four miles required by its Mexican counterpart. Hoberman has noted that we would be hard pressed to find a single tunnel of comparable length in medieval Europe too.[78] To locate a tunnel of similar length, we must turn to classical antiquity.

The Roman Emperor Claudius initiated the drainage of Fucino Lake in central Italy. Similar to our own case in Mexico City, mountains encircled the Italian lake. During the rainy season, the lake would overflow, flooding the surrounding arable land. But perhaps the lake's greatest issue was its standing waters, which produced a natural environment for mosquitos and malaria. Claudius commissioned the construction of a tunnel 3.5 miles long to drain the lake into the Liri River.[79] It was a project that was only completed in the nineteenth century. From this brief analysis of European drainage tunnels, we can gather that these structures were non-existent in early seventeenth-century Europe and the New World. As a result, Domínguez' concern about the Spanish ability to build a drainage tunnel was a valid one.

Domínguez' last worry centered on the human cost of drainage.[80] In his letter to the monarch, he alerted Philip that Indians lacked the fortitude to undertake the arduous labor required by the *desagüe*. The cosmographer posits this latter point within on-going trans-Atlantic

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[77] Hoberman, "City Planning in Spanish Colonial Government," 10.
[78] *Ibid.*
[79] Louisa Schell Hoberman, "Technological Change in a Traditional Society: The Case of the Desagüe in Colonial Mexico," *Technology and Culture* 21, no. 3 (Jul., 1980), 393.
[80] *Memoria histórica, técnica y administrativa*, 1:73.

discussion about the nature of Indians. The issue, for him, is not whether Indians could be enslaved given a so-called "natural state" in an Aristotelian sense.[81] This type of debate had already been waged between Juan Ginés de Sepúlveda, a proponent of natural servitude, and the Dominican friar Bartolomé de las Casas, a defender of Indians, in the Valladolid Debates (1550-51) to no avail. To be more precise, Domínguez' critique questioned the strength of Indian bodies to withstand hard labor.[82] He maintained that Indians were not physically capable to withstand the grueling demands of building the *desagüe*, which would ultimately cause their demise.

To return to Arciniega's proposal, the city council did not offer a decision the day the plan was presented (on February 5). Despite the city being inundated, any plan would require time to assess its merits. While Arciniega waited for the *cabildo* to render an opinion, they ordered the architect to repair the damages caused by the flood at San Agustín and Xochimilco.[83] The *cabildo* took more than two months to finally provide their judgment. On April 11, it ruled to examine no further Arciniega's recommendations for drainage.[84] By now the floodwaters had subsided and with water levels back to normal heights, the council deemed the *desagüe* unnecessary.[85]

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[81] Silvio Zavala, *The Political Philosophy of the Conquest of America*, trans. by Teener Hall (Mexico City: Editorial Cultural, 1953). In particular, see Zavala's chapter "Natural Servitude," 39-66.

[82] Domínguez' hypothesis of Indian frailty developed, in part, on the indigenous population decline after Spanish arrival. Case in point: it is estimated that the Basin of Mexico had an indigenous population between 22 and 25 million in 1519, but was under three million by mid-century. While population decline figured into a myth of Indian weakness, superhuman strength constituted part of a black bodily myth, equating the effort of four Indians to that of one African. It is doubtful that Domínguez proposed to use Africans instead of Indians in the *desagüe* given his reservations about the project's cost and technical impossibility. See Oriol Pi-Sunyer for a theory of African superhuman strength in "Historical Background to the Negro in Mexico," *Journal of Negro History* 42, no. 4 (Oct., 1957), 240.

[83] A. C., February 5, 1580.

[84] Mathes, "To Save a City," 427.

[85] There was still the matter of Arciniega's compensation. For seventeen days of work—fourteen surveying the region north of the lakes and three days at San Agustín and Xochimilco—Arciniega was paid 42 *pesos* in *oro común*. See A. C., April 11, 1580.

The Flood of 1604

Similar to the decision to abandon the *desagüe* in 1555, the colonial authorities returned to rebuilding the Aztec hydraulic network after the flood of 1580. But as we already know, a Spanish way of life made the balance between the lakes and city a tenuous one. It was only a matter of time before the next deluge would strike. In August 1604, Mexico City was again fighting the onslaught of raging current. Not unlike his predecessors, Viceroy Juan de Mendoza y Luna, Marqués de Montesclaros, ordered hydraulic structures repaired. In doing so, the viceroy looked to the Franciscan Order. Friar Juan de Torquemada was to supervise the rebuilding of the causeway of Guadalupe and the friar Gerónimo de Zárate de Salmerón, the causeway of San Cristóbal.[86] In addition to their work on the causeways, the friars also guided the repairs of drains, the raising of streets, and improvements to the dike of San Lázaro and the causeway of San Antonio de Abad.[87] Although interested in producing immediate results by repairing these hydraulic structures, Montesclaros also rekindled the idea of the *desagüe*.

The most notable drainage plan belonged to Antonio Pérez de Toledo and Alonso Pérez Rebelto. They proposed to drain the waters from Mexico City to the Gulf of Mexico via the town of Tequisquiac.[88] The scheme totaled 25,000 *varas* in length, 8 in width, and required 15,000 Indian workers laboring for six months to complete the project. Toledo and Rebelto also called for two types of supervisors to manage the workforce. Three hundred mid-level foremen were to oversee the workers, averaging one for every fifty Indians. In turn, the foremen were under the guidance of four high-level administrators. In addition, Toledo and Rebelto also called for the 2,080 *barretas* (digging bars), 2,000 pickaxes, and 7,000 baskets (for carrying soil). Each Indian

[86] Mathes, "To Save a City," 428.
[87] *Ibid.*
[88] Cepeda, Carrillo, and Serrano, *Relación universal*, 50; Mathes, "To Save a City," 428.

worker was to be paid one *peso* per week. Labor and materials were projected to cost 468,487 *pesos*.[89] When the floodwaters receded, this plan too was abandoned.

As we have seen in the first half of this chapter, *desagüe* plans were proposed and studied with the inundations of 1555, 1580, and 1604. These schemes were disregarded either when floodwaters receded or because of their costs. Without a drainage strategy to carry out, the Spanish returned to the hydraulic network to protect the city. In spite of the fact that drainage schemes were not implemented, a verifiable truth rings clear: colonial administrations looked to cartography to aid in solving the chronic problem of flooding. The absence of these maps puts us at a great loss for examining the relationship between cartography and drainage. In three years' time, however, the outcome of the *desagüe* and the role that mapmaking would play in drainage would be far different.

At Wits' End

In 1607, another flood struck the viceregal capital. On the heels of the 1604 inundation, the colonial authorities had lost all hope for the city's causeways, dikes, and floodgates to safeguard Mexico City. If the viceregal capital were to remain in its watery location, drastic measures were required. If no new water management plan were instituted, the likelihood that catastrophic inundation would forever haunt the city was an undeniable reality. The Spanish were now truly at their wits' end. They were determined to carry out the *desagüe*.

The latter half of this chapter examines a single flood proposal by the cartographer-turned-engineer Enrico Martínez. Unlike his predecessors, Martínez was afforded the opportunity to build his *desagüe* proposal. Until this point, we have examined some of the

[89] Cepeda, Carrillo, and Serrano, *Relación universal*, 50.

important issues related to flood control proposals prior to 1607. In the pages that follow, we will examine how and why the inundation of 1607 was a landmark event in colonial water management. Important to consider is how this flood was the impetus for several important changes in Spanish reasoning towards inundations from their anterior thinking. Underpinning this shift was a reconceptualization of the cost of catastrophic inundation. Before 1607, financing the *desagüe* was compared only to rebuilding the hydraulic network, which the latter required considerably less financial outlay. However, in 1607, colonial officials were no longer inclined to determine the fate of the city using this approach. Instead, the price of flooding now took account of the value of the city, which far exceeded the cost of any drainage strategy. In short, through this shift in thinking, drainage became economically feasible.

The second factor that marks this flood as a "turning point" in water management is a map. It is quite reasonable to argue that the *desagüe* alone was the significant turn in flood control. However, we cannot understand its importance without study of Martínez' *Descripción de la comarca de México i obra del desagüe de la laguna* (Fig. 2). As we have seen, maps were made in the service of flood control prior to 1607. Yet, their absence leaves us with a lacuna about how these cartographic documents portrayed their course of action. As a result, Martínez' map is an important document for the history of Mexico City water management. It is the first colonial map devoted to flood control that has survived the ravages of time, and significantly, it is first flood control map made by a professional cartographer.[90] Remember that maps studied hitherto were not made by European cartographers. They were all the work of indigenous mapmakers, or in the case of the *Nuremberg Map*, by a European. While these former images speak to the city's urban form and relationship to water, they do not purport to offer any

[90] López, "In the Art of My Profession," n. 5.

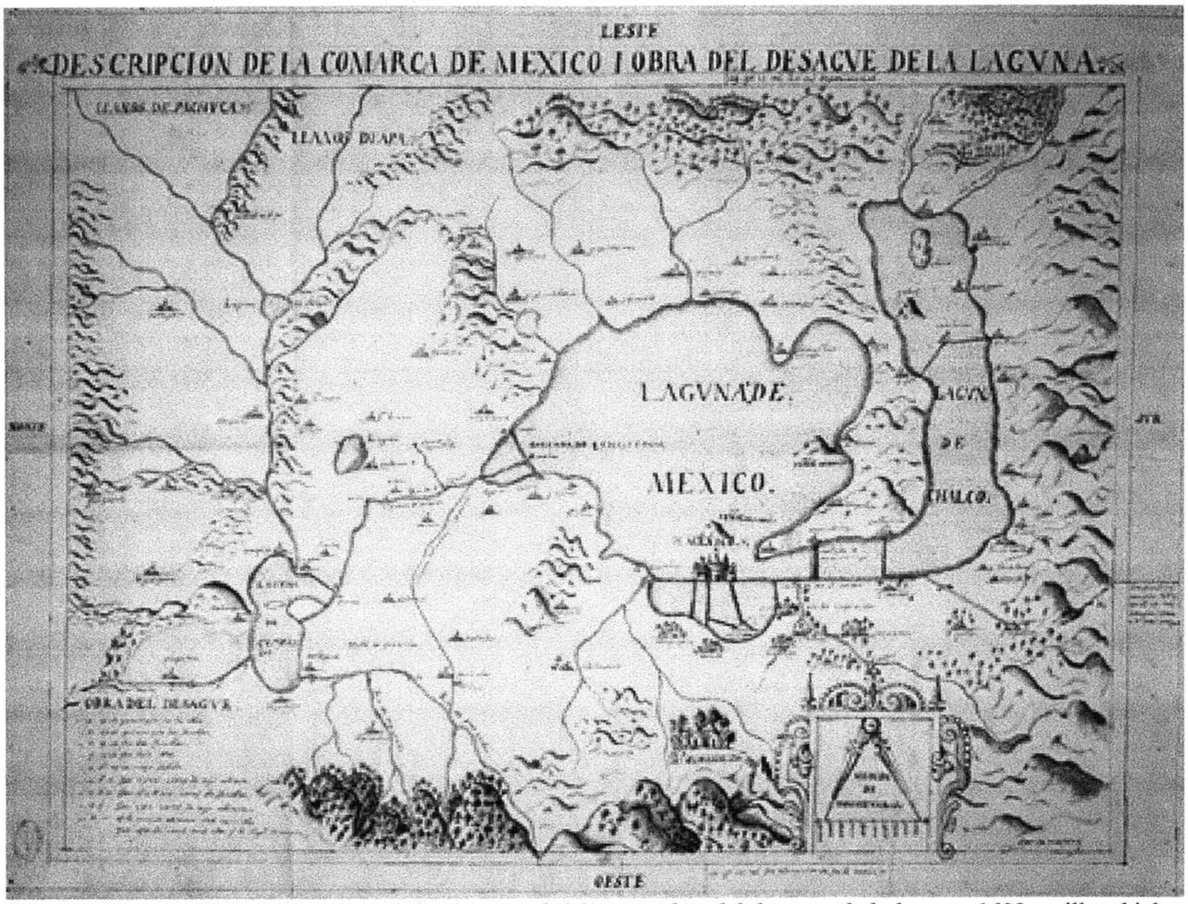

Fig. 3. Enrico Martínez, *Descripción de la comarca de México i obra del desagüe de la laguna*, 1608, quill and ink on paper, 16 1/8 in. x 21 1/4 in. (41 x 54 cm.) Archivo General de Indias, Seville. AGI-MP-México 54. Photograph provided by the Archivo General de Indias.

information that would mitigate flooding. Ultimately, I argue that a new flood control method required new comprehension about the basin, city, and lakes that previous studied maps did not aspire to offer.

Martínez was a professional mapmaker trained in the latest technologies of cartography—mathematics and science. When we examine his visual work, we will comprehend how ending the centuries-old battle against Mexico City's susceptibility to flooding was a problem posed to the scientific rationality of European Renaissance cartography. In particular, we will scrutinize the underlying cartographic principle that anchored Martínez' map, namely, mathematical abstraction. By examining this abstraction, we will consider how the city's relationship to the lakes stood in sharp contrast to earlier maps of Mexico City. We will also examine Martínez' geometric drawing to think hard about how this image frames new conceptions of the basin, city, and lakes in hopes of ending catastrophic inundation.

Martínez' map also reveals an intellectual gap in the scholarly literature on the *desagüe*. Martínez' work is the first flood control map of Mexico City that modern-day *desagüe* scholars have had the opportunity to examine, since the locations of all prior viceregal flood maps are unknown. With this cartographic lacuna in mind, it is surprising that students of the drainage project have avoided analysis of his graphic commentary. Until now, the map has been used merely as an illustration for the written analysis of the *desagüe* in general and Martínez' project in particular.[91] No in depth attempt has been made to comprehend the map's graphic information.[92] As a result, we are in dire need of an examination of Martínez cartographic work.

A Changing Mindset

In 1607, Viceroy Velasco requested drainage proposals. Specifically, he asked that architects Alonso de Arias and Juan de Peraleda and the cartographer Enrico Martínez submit

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[91] For examples of Martínez' map used solely as an illustration, see the following: Hoberman, "City Planning in Spanish Colonial Government"; Ramírez, *Memoria acerca de las obras e inundaciones en la Ciudad de México*; Maza, *Enrico Martínez: Cosmógrafo e impresor de Nueva España*; Gibson, *The Aztecs Under Spanish Rule*; Mathes, "To Save a City"; Richard Everett Boyer, *La gran inundación: vida y sociedad en la ciudad de México (1629-1638)*, trans. by Antonieta Sánchez Mejorada (Mexico City: Secretaría de Educación Pública, 1975); Peter Krieger, *Acuápolis* (Mexico City: Instituto de Investigaciones Estéticas, Universidad Nacional Autónoma de México, 2007). Perhaps surprisingly, a few instances exist where Martínez is the subject of discussion but his map was not included. For these, see: Candiani, "Draining the Basin of Mexico"; Hoberman, "Technological Change in a Traditional Society"; María Luisa Rodríguez-Sala, *Letrados y técnicos de los siglox XVI y XVII: escenarios y personajes en la construcción de la actividad científica y técnica novohispana* (Mexico City: Instituto de Investigaciones Sociales, Universidad Nacional Autónoma de México, 2002); and Valerie L. Mathes, "Enrico Martínez of New Spain," *The Americas* 33, no. 1 (Jul., 1976): 62-77.

[92] For a brief analysis of Martínez' map, see López, "In the Art of My Profession," and Priscilla Connolly and Roberto L. Mayer, "Vingboons, Trasmonte, and Boot: European Cartography of Mexican Cities in the Early Seventeenth Century," *Imago Mundi* 61, no 1 (2009): 47-66.

plans for drainage.[93] In total, five proposals were considered.[94] They belonged to Alonso Pérez Relto, Francisco Gutierrez Naranjo and Sebastian de Luna, Damian Dávila Mesura, Peraleda, and Martínez.[95] Three of the schemes, according to Hoberman, required that a discharge canal begin on the eastern shores of Lake Zumpango, which was to extend to the northeast, eventually exiting the basin and carrying its water to the Tequisquiac River.[96] Peraleda's proposal also called for waters to exit via the Tequisquiac River, but his canal was to begin at Lake Xaltocan, which lay south of Zumpango.[97]

On September 17, 1607, Martínez' proposal was presented to the city council. It called for building a canal and tunnel to take waters from Lake Zumpango into the Gulf of Mexico.[98] The discussion that ensued is revelatory of a changing mindset regarding drainage. Consider, for instance, that city treasurer Diego de Ochandiano viewed Martínez' plan as indispensable for saving Mexico City because its cost would be "no greater than the [value of the] buildings saved."[99] It was a point favored by city council members Francisco de Trejo Carvajal, Francisco de Yrrazabal, and Pedro Núñez de Córdoba.[100] With the value of the city's buildings now being included as part of the financial analysis associated with disaster, the pendulum quickly swung in favor of the *desagüe*.

93 Every Wednesday during the months of August and September, Velasco met with *oidores* (judges) Licenciado Pedro de Otalora, Diego Núñez Morquecho and Doctor Juan Quesada de Figueroa to review proposals. See, Mathes, "To Save a City," 430. For Martínez' report on the d*esagüe* in manuscript form, see Archivo General de la Nación, Desagüe, vol. 3, exp. 1. In its published format, consult "Relación de Enrico Martínez, año de 1628," in *Obras públicas en México*, 3:27-39.
94 Hoberman, "City Planning in Spanish Colonial Government," 62-63.
95 *Ibid.*
96 *Ibid.*
97 *Ibid.*, 63.
98 Mathes, "To Save a City," 430.
99 Mathes, "To Save a City," 430; Hoberman, "City Planning in Spanish Colonial Government," 60.
100 Mathes, "To Save a City," 430; Hoberman, "City Planning in Spanish Colonial Government," 60.

On October 1, 1607, Viceroy Velasco and a cohort of city administrators (Otalora, Núñez, Morquecho, Quesada de Figueroa, Trejo Carvajal, Maldonado de Corral, Escudero de Figueroa), and Alonso de Arias, Andrés de la Concha, Juan de Cevicos, Martínez, and others set out to survey possible sites for the *desagüe*.[101] Two days later the viceregal party reviewed four proposals *in situ*. On October 4, Martínez' plan was also studied in the field. The next day, hearings were held to discuss the merits of each proposal.[102] It was decided that Martínez had correctly identified the causes for flooding (while others had not), and that his plan was financially judicious, diverted the least Indian labor from other profitable activities, and could be completed expeditiously.

Martínez' *desagüe* strategy was indeed cost-effective. Consider, for instance, that his route was three-fourths the length of any of the drainage plans that included the Tequisquiac River as the point of discharge.[103] Martínez' *desagüe* was 7.4 miles in length, while the Tequisquiac option had a distance of 10 miles.[104] Aside from this difference, other factors made Martínez' plan more appealing to the colonial authorities. For example, the mouth of his canal was directly opposite from the point where the Cuautitlán River emptied into Lake Zumpango.[105] Other schemes called for respective drainage canals to begin on the eastern side of Lake Zumpango, while a fourth argued for Lake Xaltocan as the place where discharge should commence. In these latter four proposals, the Cuautitlán's water would be allowed to travel longer distances within the lakes, and thus potentially would put the city at greater risk of flooding. A third detail that must surely have influenced officials' decision was the depth of the

[101] Mathes, "To Save a City," 430; Hoberman, "City Planning in Spanish Colonial Government," 62.
[102] Mathes, "To Save a City," 431.
[103] Hoberman, "City Planning in Spanish Colonial Government," 66.
[104] *Ibid.*
[105] *Ibid.*

tunnel portion of the respective *desagüe* proposals. The path championed by Martínez (by the way of Huehuetoca) was estimated to require a tunnel having a maximum depth of 92.66 feet below the surface of the earth, while the Tequisquiac River option required digging to a depth of 214.5 feet.[106] If we consider that Martínez' course of action saved 2.4 miles (in length) and almost 122 feet (in depth) of digging, we can thus understand how his plan was more economical than that of his counterparts. After several interim meetings, Martínez' *desagüe* strategy was formally accepted on October 23, 1607.[107]

Martínez' drainage plan relied solely on gravity to discharge waters. He calculated that a ratio of ¼ *vara* of slope for every 1,000 *varas* of run was sufficient to achieve his intended goal.[108] To allow for air, light, maintenance and repairs of the tunnel, forty-two shafts were built.[109] In a technical description of these shafts, Martínez provided their respective depths.[110] Borrowing from mining technology, the shaft would allow also for the mechanical removal of excavated earth via hoists operated by beasts of burden, hence saving on Indian labor.[111] A second, and lesser-known phase, included the construction of an additional canal, which was to extend from Lake Mexico to Lake Zumpango via the town of San Cristobal.[112] The first phase of

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106 *Ibid.* Hoberman noted that the true depth of Martínez' tunnel was 148.5 feet. This increase in depth was due to account for the slope required to drain water away from the basin.

107 Mathes, "To Save a City," 432; Maza, *Enrico Martínez*, 108.

108 Enrico Martínez, "Quenta y medida de lo que cada parte de la obra del desagüe á de tener en fondo desde la superficie de la sierra hasta el plan, para que pueda desagüar por ella el agua de la laguna de México," 2:18-21. On the other hand, San Miguel proposed that Martínez had suggested a ½ *vara* of slope for every 1,000 *varas* of run. See San Miguel, *Obras de fray Andrés de San Miguel*, 328.

109 Hoberman, "City Planning in Spanish Colonial Government," 89. The depth of the tallest shafts has been suggested to be as short as 54 meters. See Alain Musset, *El agua en el Valle de México, siglos XVI-XVII*, trans. Pastora Rodríguez Aviñoa and María Palomar (Mexico City: Pórtico de la Ciudad de México / Centro de Estudios Mexicanos y Centroamericanos, 1992), 198. On the other hand, San Miguel offered they were as tall as 72 meters. Consult, San Miguel, *Obras de fray Andrés de San Miguel*, 326.

110 Martínez, "Quenta y medida de lo que cada parte de la obra del desagüe," 2:20-21.

111 Candiani, "Draining the Basin of Mexico," 49-50; Cepeda, Carrillo, and Serrano, *Relación universal*, 73.

112 Martínez, "Relación de Enrico Martínez," 2:8-10. See also Hoberman, "City Planning in Spanish Colonial Government," 69. Hoberman refers to Lake Mexico as Lake Texcoco in her dissertation. We must keep in mind that

the plan was intended to drain the upper-lying Lake Zumpango, but additional infrastructure was required to achieve total drainage. The second discharge canal was needed for drying the lower-lying Lake Mexico that surrounded the city. The total length of both phases was estimated at 18.6 miles.[113] Each phase had an estimated cost of 300,000 *pesos*.[114] To raise funds for the *desagüe*, a tax on city property was levied, and to help assess this excise, Viceroy Velasco commissioned the architect Andrés de la Concha to produce a map of the city.[115] Property was taxed at 1.5% of its assessed value.[116] The tariff however was not applied democratically. Ecclesiastical property was taxed at the lower rate of .75%.[117] With the worth of the city's buildings estimated at 20,267,555 *pesos*, 304,013 *pesos* were raised towards the *desagüe*.[118] With enough funds to build only the first stage of the project, the second phase was put on hold.

On November 28, 1607, after hearing Mass and in front of 1500 Indian workers, Viceroy Velasco broke ground on the *desagüe*. By early 1608, the canal portion of the *desagüe* was almost complete and work on the tunnel had begun.[119] In mid-March, Martínez' canal received a satisfactory review.[120] On May 20, the canal passed its first test by draining waters from Lake Zumpango to the mouth of the tunnel, where a temporary earthen dam held the water at bay.[121]

Texcoco and Mexico were interchangeable when referring to the lakes even though they represented two different bodies of water.

113 Hoberman, "City Planning in Spanish Colonial Government," 70.

114 *Ibid.*, 81.

115 *Ibid.*, 83. For an understanding of Concha's body of work see Martha Fernández, *Arquitectura y gobierno virreinal: los maestros mayores de la Ciudad de México, siglo XVI* (Mexico City: Universidad Nacional Autónoma de México, 1985), 65-76. Regrettably, the location of this map is also unknown.

116 Hoberman, "City Planning in Spanish Colonial Government," 83.

117 *Ibid.*

118 Cepeda, Carrillo, and Serrano, *Relación universal*, 81; Mathes, "To Save a City," 432; Candiani, "Draining the Basin of Mexico," 58; Hoberman, "City Planning in Spanish Colonial Government," 83; Hoberman, "Bureaucracy and Disaster," 212; and Rodríguez-Sala, *Letrados y técnicos de los siglox XVI y XVII*, 149.

119 Mathes, "To Save a City," 433.

120 The tunnel was found to be less than adequate. To improve its capacity, its width was increased from two *varas* to five and its height augmented to four. See San Miguel, *Obras de fray Andrés de San Miguel*, 328; Mathes, "To Save a City," 434.

121 Mathes, "To Save a City," 435.

Work continued on the tunnel and on September 18, Martínez broke the provisional dam, allowing waters from Lake Zumpango to flow. The next day, Viceroy Velasco observed water exiting at Nochistongo. In the surprising time of less than ten months, Martínez had completed the first phase of the *desagüe* with only the aid of Indian labor, beasts of burden, and simple machines. Martínez's *desagüe* represents an innovative solution to the city's flood problem, by finally breaking free from the pre-Columbian model of containment and regulation, and any of the Spanish undertakings that resembled it.[122]

Mathematical Abstraction

Today, *Descripción de la comarca de México i obra del desagüe de la laguna* can be found in the Archivo General de Indias (AGI) in Seville, one of Spain's repositories for all things related to the Spanish New World. A quill and sepia-colored ink drawing on paper, it measures 41 x 54 cm (16 ⅛ x 21 ¼ in.). A simple two-part border composed of three lines frames all four sides of the map. Besides two small floral details flanking the title of the map and the AGI's stamp in the lower left-hand corner (obviously added at a later date), no other decorative elements are to be found within the outer edges of the map. In lieu of any ornamentation, textual descriptions inhabit this space. At the top of the map, above the title, we find the word "LESTE," Spanish for east. Along this outer border, in a clockwise direction, "SUR," "OESTE," and "NORTE" indicate the other three directions. Within the inner portion of this unadorned border (just below the title), Martínez provides us with Mexico City's latitude, 19° 15' N. This figure was only 11' off its actual location.[123] For the city's longitude, the cartographer provides 257°

[122] Hoberman has also pointed out that Martinez ingeniously applied mining technology to the building of the *desagüe*.
[123] Mexico City's latitude is 19° 26' N.

12' from the "ancient meridian." Martínez conceived of this latter measurement as beginning at the meridian, moving eastward, circumventing three-quarters of the globe until reaching Mexico City. Today, Mexico City's longitude is calculated at 99° 7' W, or 260° 3'using Martinez' method. Surprisingly, he was only 2° 51' shy of his mark, an impressive feat given that determining longitude during this time was not an exact science.[124] Equally as significant, these coordinates speak to Martínez' understanding of the new science of geography.

Important for comprehending Martínez' formulation is mathematical projection. The cartographer's hand-written coordinates allow us to know Mexico City's "true nature and location," a concept Ptolemy introduced in his theory of geography. This is the first significant difference between Martínez' map and the previously examined maps of the island city. Call to mind that none of these maps were based on mathematical abstraction. To appreciate Martínez' mathematical thinking, we must turn to Ptolemy and his conception of the world.[125] For the ancient Alexandrian, the world is organized into a mathematical coordinate system, where it is divided into latitudes and longitudes. Each represents a value established from the equator or prime meridian, respectively. Historian of cartography Evelyn Edson has argued that Ptolemy offered a "systematic and measured vision of the ordering of space, base on the abstract principles of Euclidean geometry."[126] Unlike chorography, the intention of geography is to "consider the whole, universally."[127] As such, geographical places are situated in relation to

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[124] By today's standards, Martínez was off by 196.5 miles.

[125] For an understanding of Ptolemy's work, see J. Lennart Berggren and Alexander Jones, *Ptolemy's Geography: An Annotated Translation of the Theoretical Chapters* (Princeton: Princeton University Press, 2000); Evelyn Edson, "The Recovery of Ptolemy's Geography," in *The World Map, 1300-1492: The Persistence of Tradition and Transformation* (Baltimore: Johns Hopkins University Press, 2007), 114-140; and Maria A. Portuondo's chapter "Renaissance Cosmography in the Era of Discovery," in *Secret Science: Spanish Cosmography and the New World* (Chicago: University of Chicago, 2009), 19-59.

[126] Edson, *The World Map*, 119; Portuondo, *Secret Science*, 20-21. Portuondo argues that cosmography during the Renaissance integrated three classical traditions: Aristotelian natural philosophy, Euclidean geometry, and Ptolemaic geography.

[127] As quoted in Cosgrove, "Mapping New Worlds," 66.

others locations, each assigned a set of coordinates. In the Ptolemaic system the "privileged center," as in the case of Jerusalem in the medieval *mappamundi*, is simply just another point on the grid."[128] To emphasis this point even more, historian of science María A. Portuondo has argued that the *mappamundi* was "deeply embedded in religious consciousness" and "meant to provide a temporal and spatial reckoning of significant events rather than to depict geography."[129] For Ptolemy, and later for Martínez, mathematical coordinates are the basis for geographical knowledge. Yet Martínez' map is not a projection of the earth or even its continents. The problem of flood control did not require a cohesive image of all of Spanish America. Rather, it called for an intimate look at the Basin of Mexico. In this respect, Martínez' visual work is unlike Ptolemy's conception of geography, but his written coordinates are not. As a result, we must consider Martínez' coordinates as functioning within the Ptolemaic system to situate the viceregal capital in a world that is mathematically ordered, but that purposely lacks the cartographic image of landmass associated with it.

Let us consider *Descripción de la comarca de México i obra del desagüe de la laguna* in relation to the *Uppsala Map*. Both maps identify the basin and its geographical terrain. Both show us Mexico City within its lake setting. Mountain ranges in the pair frame the edges of each. Likewise, east is at the top of each image. Despite these similarities, they are not identical. Consider again, for example, how the *Uppsala Map* distinguished between the countryside and island city and how the former was vibrant with color and human activity. With but a quick glance at Martínez' map, we easily detect that it lacks any portrayal of social activities. Simply put, the map is void of people—Spaniards and Indians—in any activity that is indicative of early seventeenth-century life. For Martínez, a solution to the city's flood problems did not require a

[128] Edson, *The World Map*, 119.
[129] Portuondo, *Secret Science*, 33.

description of social relations. In addition, topographical features—rivers, mountains, and trees—and built elements—cities, towns, and churches—are described monochromatically, devoid of any pigment save for the sepia-colored ink used to draw the map. In lieu of additional color, cartographic techniques—line, cross-hatching, stippling, stippling, and shading—highlight differences in geography and architecture. These techniques attest to Martínez' professionalization as a cartographer.[130]

Crucial for understanding Martínez' conception of drainage is to comprehend how he employed mathematical abstraction in his description of the basin. In the lower right-hand corner of the map, the German mapmaker presents us with a richly decorated ornamental frame (Fig. 4). In noticeable contrast to his unadorned border, the cartouche is an impressive depiction of architectural space. Volutes and pinnacles frame a richly decorated exterior double frame. Within this architecturally defined space, Martínez highlights a dividing compass. Its two arms, connected by a circular hinge, are outstretched over a scale bar measuring ten thousand *varas*. This is a simple but important tool of cartography that with its associated scale bar visually demonstrates the rationale behind Martínez' *desague*: mathematical abstraction. This abstraction marks another break in the maps of Mexico City. The implications of the cartouche, compass, and scale bar are clear: art and science work in unison to convey the idea of precise measurement. Examined within this light, "accuracy," as historian of cartography J. B. Harley has argued, "became a new talisman of authority."[131] Cartographic ornament in the case of

[130] Valarie Mathes' 1976 essay on Martínez highlights his professional endeavors as author, Inquisition interpreter, cartographer, printer, and engineer. See "Enrico Martínez of New Spain." According to Maza, Martinez spoke Latin, Spanish, German, and Dutch (*Enrico Martínez*, 13). In Paris, France, he received a degree in mathematics (*ibid.*, 20; Mathes, "Enrico Martínez of New Spain," 63). Martínez arrived in New Spain in 1589 (Maza, *Enrico Martínez*, 20; Mathes, "Enrico Martínez of New Spain," 63; and Enrico Martínez, *Reportorio de los tiempos e historia natural de Nueva España* [Mexico City: Secretaría de Educación Pública, 1948], xiii).
[131] Harley, *The New Nature of Maps*, 77.

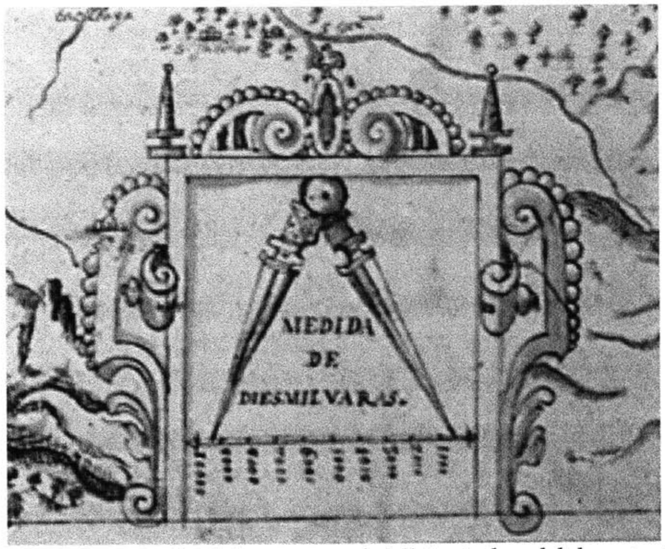


Fig. 4. Compass with Scale Bar, *Descripción de la comarca de México i obra del desagüe de la laguna* (Detail).

Martínez' cartouche thus was not a simple, neutral exercise in aesthetics, but rather, this decorative element reinforced the map's depiction of geometric accuracy.[132]

With compass and scale bar, Martínez establishes the rules by which the map is to be understood. He instructs the viewer how to conceive of spatial relationships—between topographical features such as lakes, mountain, and rivers, and cities and towns—as geometric. Yet geometry alone cannot fully describe the *desagüe* or how it was to function. Geometry is one part of a two-part system. Key for communicating Martínez' *desagüe* strategy is the legend opposite the cartouche. In the lower left-hand corner of the map, we find this legend, entitled *Obra del Desagüe* (Fig. 5). In quite noticeable difference, the legend lacks any architecturally ordered space. No cartouche or decorative elements frames it. Oddly, it occupies an amorphous area on the map. The map's border to the left of the legend and below it frame two of its sides. A mountain range to the right and the path of the *desagüe* directly above the legend's title complete this irregularly shaped zone.

[132] *Ibid.*, 73 and 136.

Fig. 5. Legend, *Descripción de la comarca de México i obra del desagüe de la laguna* (Detail).

Read together, legend, compass, and scale bar offer comprehension of Martínez' strategy. As the map clearly indicates, the mouth of the *desagüe* canal, identified with the letter "a," sits at the northwestern corner of Lake Zumpango (Fig. 6). Across the lake, on its southwestern side, the Cuautitlán River empties into Zumpango. From point "a," Martínez called for the construction of a canal that would extend northward for 7,500 *varas* to the town of Huehuetoca, which is labeled as point "c." Four nondescript facades identify point "c" with the Spanish word "gueguetoca" (Huehuetoca) directly above them. The canal would then meet a tunnel measuring 7,670 *varas* in length that would breach the basin's northern mountains to deliver the waters to the Gulch of Nochistongo, identified as point "e" on the map. From Nochistongo, a second canal measuring only 780 *varas* would take the basin's waters to the Tula River, which eventually flowed into the Gulf of Mexico.

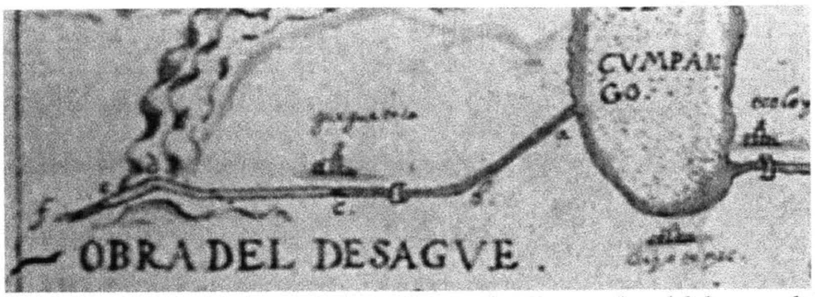
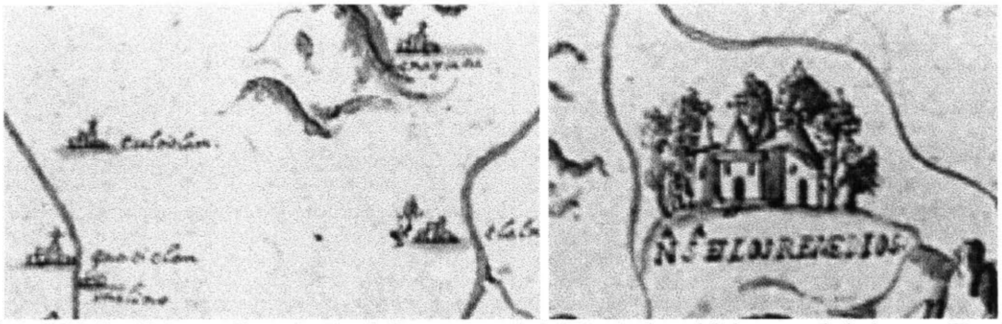


Fig. 6. Path of the *Desagüe*, *Descripción de la comarca de México i obra del desagüe de la laguna* (Detail).

Mathematical abstraction underpins the character of *Descripción de la comarca de México i obra del desagüe de la laguna*. This occurred in two ways. First, Martínez' written coordinates situates Mexico City in a mathematical conception of the world based on the Ptolemy's theory of geography. The second also portrays spatial relationships as geometric. However, this occurred at a more intimate level. Due to this shift in scale, the map's mathematical order was not dependent on global coordinates but rather on a measured drawing.

Mexico City: A Cartographic Symbol

Until now, we have examined how *Descripción de la comarca de México i obra del desagüe de la laguna* stresses the importance of mathematical abstraction in the service of flood control. Let us now turn to how Martínez described Mexico City and its relationship to the lakes. To begin with, consider, for example, how mainland settlements are portrayed as a series of buildings clustered together in elevation, often with a church with a steeple being the most recognizable form (Fig. 7). The function of other nearby structures is difficult to discern, given the sparse treatment. A quick glance at the rest of the map reveals this same nondescript



Figs. 7 & 8. Mainland Towns, *Descripción de la comarca de México i obra del desagüe de la laguna* (Details).

architectural vocabulary at work to describe other towns. Spanish glosses aid the viewer in knowing the names of these settlements, but no other information about them is provided. By looking at them we are unable to comprehend their spatial character. Simply put, they are represented as cartographic symbols. The architectural vocabulary employed is a generic one. Even in the context of religious piety, the sanctuary of Nuestra Señora de los Remedios, located near the present-day town of Naucalpan (below Mexico City and to the left of the cartouche), is described within this same architectural language (Fig. 8).

Perhaps not surprisingly, Martínez used a similar visual language to portray the viceregal capital (Fig. 9). Take, for instance, how the island city is represented as a collection of building façades. A centrally positioned cathedral with steeple pointing towards the "I" in "Mexico" is flanked by less prominent buildings of a similar level of articulation. Including the cathedral's, five crosses denote religious structures.[133] The capital is shown to us as a series of closely huddled buildings of varying heights. It rests upon a causeway. Three other causeways can be seen stretching towards from the island city to the mainland. Aside from this outward appearance of the city where the cathedral has become the "face" of the capital, we are provided no clues as

[133] Like its mainland counterparts, we cannot determine the function of nearby buildings based on an observation of their form.

Fig. 9. Mexico City, *Descripción de la comarca de México i obra del desagüe de la laguna* (Detail).

to Mexico City's architectural character. Absent from Martínez' graphic representation are also the city's canals. Missing too is the dike of San Lázaro. To point to a third example, the city's *chinampas* are nowhere to be found. Besides the causeways and the Lake of Mexico, Martínez offers no commentary on the aquatic traits of the city. The omission of the city's hydrographic condition is glaring. In marked contrast to how the *Nuremberg Map*, folio 2r of the *Codex Mendoza*, *Uppsala Map*, and *Plano en papel maguey* portrayed the city's relationship to the lakes, Martínez is unconcerned with how water shaped the capital. To put it simply, we are left to our imagination to ponder the nature of the city's aquatic character in Martínez' map.

To situate the cartographer's approach for chronicling Mexico City within a broader context, we need to look no further than the *Uppsala Map* and *Tres diálogos latinos*. They described the capital from a cartographic and a literary standpoint, respectively. Both supplied us with vivid images of the viceregal capital's urban fabric. Call to mind that the *Uppsala Map* and

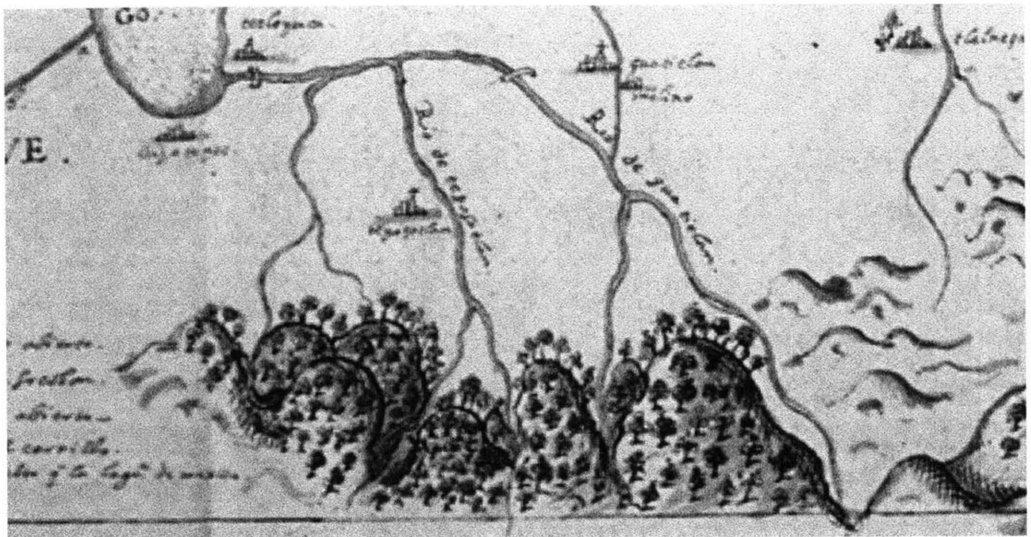


Fig. 10. Cuautitlán River, *Descripción de la comarca de México i obra del desagüe de la laguna* (Detail).

Tres diálogos latinos are chorographic in scope and that the premise of chorography is to convey the quality of a place in its "true form or likeness."[134] From our study of the capital, we know now that Martínez' intention was never to provide a chorographic image of Mexico City. Like the mainland town, Mexico City also stands as a cartographic symbol. Conceived in this way, the map reveals that Martínez thought of the island settlement in terms similar to those of land-based towns. This method for chronicling the viceregal capital suggests that how the capital was graphically described is secondary to the objective of flood control. Ending inundation was an enterprise to take place in the northern region of the basin and not the city. This point leads us to consider how the cartographer described the Cuautitlán River.

Martínez identifies a network of rivers and streams that descend from the surrounding mountain ranges to flow across the basin floor in his map. Eventually, these rivers make their way to one of the six lakes that compose the aquatic region. Cartographically, these rivers are treated in a similar fashion. Two simple lines and light shading outline their undulating form.

[134] Cosgrove, "Mapping New Worlds," 66.

Despite the attention to the region's waterways, Martínez is primarily concerned with only one river: the Cuautitlán. This waterway, the source of the capital's flood problems, can be found in the lower half of the map, between the legend on its left and the cartouche on its right (Fig. 10). Perhaps to indicate its turbulent currents, the cartographer shows the Cuautitlán in a different manner than other nearby rivers. Note how these rivers begin from indeterminate points within the mountains. Decidedly different is how the Cuautitlán is depicted. It is illustrated as emerging from a mountain range that is split in two. It springs forth from a V-shaped crevasse, where the mountains on either side lean away from the river. Ultimately, the river can be seen flowing into Lake Zumpango, where the *desagüe* was to begin.

Conclusion

Drainage was a novel solution to the age-old problem of flooding at Mexico City. Plans were considered with the floods of 1555, 1580, and 1604, but it was not until 1607 that the *desagüe* was finally constructed under the supervision of Enrico Martínez. In our examination of this fifty-two-year period, we have come to understand several key points. First, the origins of the *desagüe* were not as straightforward as previously believed. By scrutinizing Francisco Gudiel's flood control strategy of 1555, we learned how drainage was to be part of a multi-layered plan of water management that also aimed to ameliorate droughts, pestilence, and "resistance." Equally as important, this plan was not based on the idea of total drainage, as it sought to provide the city with the water it required. In short, for Gudiel, water was not the cause of catastrophic inundation, but rather its excess.

Second, with an increase in the incidence of flooding, the Spanish believed that the Aztec hydraulic network was flawed. This reasoning, however, does not identify the reasons for a surge in inundation at the capital city. As noted, Spanish practices were central in causing flooding. In particular, the filling of canals and the lack of attention paid to sealing off breaches in hydraulic structures undoubtedly weakened the network's ability to regulate the ebb and flow of the lacustrine environment. Moreover, changes in land use with the introduction of European agricultural methods and cloven-hoofed animals destabilized the region's topsoil. With annual rains, the loosened earth was washed into the lakes, silting them, and thus increasing the probability of flooding.

Third, with the floods of 1555, 1580, and 1604, the colonial authorities called for and examined drainage proposals. Ultimately, drainage plans were abandoned when floodwaters receded or when their respective costs overshadowed those of rebuilding the existing hydraulic network. By rejecting one *desagüe* scheme after another, the Spanish authorities were left with only one real option: to combat flooding by returning to the Aztec method. Even though the Spanish rebuilt dikes, causeways, and floodgates, they were never convinced of their ability to withstand floodwaters, viewing them with skepticism. Fourth, with the flood of 1607, the Spanish authorities were finally at their wits' end. This flood was a landmark event that changed the way the Spanish conceived of catastrophic inundation. Hitherto, the cost of the *desagüe* was compared to the cost of rebuilding the hydraulic network. However, with the value of Mexico City's buildings now factored into the financial loss of catastrophic inundation, the *desagüe* was viewed as necessary for saving the city.

Historiographically, the dearth of studies on *Descripción de la comarca de México i obra del desagüe de la laguna* presents us with a great intellectual gap in our understanding of the *desagüe*. The *desagüe* represented a new stage in flood control efforts in Mexico City, and as a result, new comprehension regarding the hydrographic condition of the basin was required. The absence of colonial-era flood control maps prior to 1607 highlights the importance of Martínez' map—not only for understanding how drainage was to occur, but equally as important, just how differently the cartographer conceived of the city's relationship to the lakes. Recall that the sixteenth-century images studied in Chapter 1 represented diverse cartographic methods for understanding Mexico City and its relationship to the lakes by drawing from a broad spectrum of mapping traditions encompassing the Old and New Worlds. They ranged from methods employed in late medieval Europe to pre-Columbian and early colonial efforts to emphasize geography as history, human bonds, and chorography, among others. However striking these maps may be, they would have been of little value to Martínez since they offered only tangential information regarding flooding and provided no knowledge for implementing the *desagüe*. For Enrico Martínez, the city's aquatic condition was not a product of history or social relations, but a problem posed by nature to rational cartographical analysis. *Descripción de la comarca de México i obra del desagüe de la laguna* is the first drawing made in the service of flood control by a professional European mapmaker. At the root of this map was mathematical abstraction, which was employed to overcome the challenges presented by the city's natural surroundings and its historical path of development. As such, the city's relationship to the lakes was irrelevant, and thus one possible reason why the capital could stand as a cartographic symbol.

Chapter 4:

"In the Art of My Profession":

Adrian Boot and Dutch Water Management in Colonial Mexico City

Despite the importance of Martínez' map in the histories of water management and cartography of Mexico City, the *desagüe's* success was short-lived. In 1614, the Dutch hydraulic engineer Adrian Boot arrived in Mexico City to assist Martínez. However, Boot dismissed drainage altogether, igniting a professional disagreement between the two men. In the fall of 1614, Boot presented a plan arguing against the *desagüe*. Boot's position came as a surprise since the Spanish monarch Philip III had commissioned the Dutchman after an international search to locate an engineer capable of assisting Martínez with the drainage project. Arguing that the *desagüe* had so far proved unsatisfactory, the new engineer instead proposed that regulating the lakes was a better method for preventing flooding. Many, especially Martínez, criticized Boot's plan because it resembled Aztec flood control.[1] Despite the similarities with the Aztec method, Boot's approach actually drew from water management practices developed in the Low Countries. Yet Mexico City's social and environmental character was different from those found in Dutch settlements, in ways that posed problems for implementing Low Countries' hydraulic technology in a wholesale fashion. Boot understood the differences, but he also recognized how and why Mexico City drew great benefit from the lakes—a relationship that Martínez and the other proponents of drainage failed to appreciate.

Arguing that the *desagüe* would never save Mexico City from flooding, Boot went against conventional wisdom to make a case for preserving the lakes, recommending the use of Dutch hydraulic technology used in drying inland lakes in the Netherlands and in other European

[1] AGN: Desagüe vol. 3, exp. 1, f. 5v.

countries. On the surface, hydraulic technology for draining lakes and the preservation of the lacustrine environment at Mexico City are incongruent aims. But how and why could Boot combine two diametrically opposed methods for water management in a single flood control plan? In this study, I explain why Boot, even though a drainage engineer, rejected the *desagüe* as a solution to flooding; why he championed a water management plan centered on containment and regulation of the lakes, and thus their preservation; and how he reimagined Dutch hydraulic technology to suit the environmental and social character of the island of Mexico City.

Historiography on the *Desagüe*

Studies on water management at Mexico City have primarily focused on the *desagüe* and its "architect" Enrico Martínez. In English, Hoberman examined the bureaucratic difficulties implementing the drainage project.[2] In a later essay, entitled "Technological Change in a Traditional Society: The Case of the Desagüe in Colonial Mexico" (republished in 1998), she explained how "new" technology in the form of the *desagüe* was to maintain Mexico City's preeminence as Spain's New World administrative center and traced how it was "undermined by social conservatism."[3] Hoberman briefly examined three alternative proposals to drainage, including Boot's, and stated that the Dutch engineer wanted to "introduce the most advanced European techniques and machines" for flood control at Mexico City, but only provided a general overview of his plan.[4] Barrera-Osorio undertook analysis of how knowledge was

[2] Hoberman, "Bureaucracy and Disaster."
[3] Louisa Hoberman, "Technological Change in a Traditional Society: The Case of the Desagüe in Colonial Mexico," *Technology and Culture* 21, no. 3 (1980): 386-407. Republished under the same title in *Land Drainage and Irrigation*, ed. Salvatore Ciriacono, 269-290 (Aldershot; Brookfield, USA: Ashgate / Variorum, 1998). My reference is from the 1980 publication, 407.
[4] Hoberman, "Technological Change in a Traditional Society," 407.

obtained empirically in many of the desagüe proposals from 1555 to 1607.[5] Valarie L. Mathes' essay on Martínez highlighted his professional endeavors as author, Inquisition interpreter, cartographer, printer, and engineer of the *desagüe*.[6] W. Michael Mathes examined the colonial flood control schemes leading to Martínez' project, identifying its political, financial, and engineering complexity.[7] Candiani's dissertation investigated the scientific and technological aspects of the desagüe, while Hoberman's dissertation explained the administrative and bureaucratic challenges of this earthwork project.[8] Recently, Candiani examined a series of late eighteenth-century sectional drawings to underscore the "influence of [European] scientific and technical culture" on the drainage project, and in a separate essay, explained the "environmental dimensions of class conflict" brought about by the *desagüe*.[9]

In Spanish, the *Relación universal* by Cepeda, Carrillo, and Serrano is a publication of primary source material, providing a first-hand explanation of flood control.[10] Ramírez offered a general account of water management from pre-Columbian times to 1637.[11] Gurría Lacroix undertook to explain the *desagüe* for the viceregal period; Lemoine Villicaña for the national; and Perló Cohen for the *Porfiriato*.[12] Rodríguez-Sala tackled scientific and technical knowledge in the sixteenth and seventeenth centuries and includes analysis of the *desagüe* and its

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[5] Antonio Barrera-Osorio, "Experts, Nature, and the Making of Atlantic Empiricism," *Osiris* 25, no. 1 (2010): 129-148.
[6] Mathes, "Enrico Martínez of New Spain."
[7] Mathes, "To Save a City."
[8] Candiani, "Draining the Basin of Mexico," and Hoberman, "City Planning in Spanish Colonial Government."
[9] Candiani, "Bourbons and Water." See also Vera Candiani, "The Desagüe Reconsidered: Environmental Dimensions of Class Conflict in Colonial Mexico," *Hispanic American Historical Review* 92, no. 1 (Feb., 2012): 5-39.
[10] Cepeda, Carrillo, and Serrano, *Relación universal.*
[11] Ramírez, *Memoria acerca de las obras e inundaciones en la Ciudad de México.*
[12] Gurria Lacroix, *El desagüe del Valle de México durante la época novohispana*; Ernesto Villicaña Lemoine, *El desagüe del Valle de México durante la época independiente* (Mexico City: Universidad Nacional Autónoma de México, 1978); and Manuel Perló Cohen, *El paradigma porfiriano: historia del desagüe del Valle de México* (Mexico City: Programa Universitario de Estudios Sobre la Ciudad, Instituto de Investigaciones Sociales: M. A. Porrúa Grupo Editorial, 1999).

engineers.[13] In French, Musset provided a general overview of the drainage project and its many proposals.[14]

Other authors have examined Boot's work in the areas of military engineering and cartography. Sluiter identified Boot's participation at the fort at Acapulco.[15] Mayer, later Connolly, and Connolly and Mayer (as collaborators) explained the provenance of four now-lost manuscript maps attributed to Boot and Juan Gómez de Trasmonte.[16] Mayer and Connolly tackled the mystery of how these early seventeenth-century maps of New Spain made their way to Europe to be copied by Johannes Vingboons and explained the inclusion of these copies in atlases, their differences, and the location of these books of maps in archives and libraries in Europe, the U. S., and Latin America. Only briefly do the authors analyze these maps within an examination of water management, as their primary intention is "cartobibliographic."[17]

A lone article is devoted to Boot. Marley's essay of just over three pages is a general account of Boot's travel from France to Spain to Mexico City; his military work at the forts of Vera Cruz and Acapulco; his arrest by the Spanish Inquisition; and briefly, his water management plan at Mexico City.[18] Unfortunately, Marley erred by claiming that Boot was not only a proponent of drainage, but that he also supervised the *desagüe* for ten years.[19] Hitherto, no

[13] María Luisa Rodríguez-Sala, *Letrados y ténicos de los siglos XVI y XVII: escenarios y personajes en la construcción de la actividad científica y técnica novohispana* (Mexico City: Instituto de Investigaciones Sociales, Universidad Nacional Autónoma de México: Miguel Ángel Porrúa, 2002).
[14] Alain Musset, "De Tlaloc a Hippocrate L'eau et l'organisation de l'espace dans le bassin de Mexico (XVIe-XVIIIe siècle)," *Annales. Histoire, Sciences Sociales* 46, no. 2 (Mar. – Apr., 1991): 261-298.
[15] Engel Sluiter, "The Fortification of Acapulco, 1615-1616," *Hispanic American Historical Review* 29, no. 1 (Feb., 1949): 69-80.
[16] Roberto L. Mayer, "Trasmonte y Boot: sus vistas de tres ciudades mexicanas en el siglo XVII," *Anales del Instituto de Investigaciones Estéticas* 27, no. 87 (2005): 177-198; Priscilla Connolly, "¿El mapa es la ciudad? Nuevas miradas a la *Forma y Levantado de la Ciudad de México 1628* de Juan Gómez de Trasmonte," *Boletín del Instituto de Geografía,* no. 66 (2008): 116-134; and Connolly and Mayer, "Vingboons, Trasmonte and Boot: European Cartography of Mexican Cities in the Early Seventeenth Century."
[17] *Ibid.*
[18] David Marley, "Adrian boot, a Dutch Engineer in Colonial New Spain (1614-1637)," *Canadian Journal of Netherlandic Studies* 4-5, no. ii-i (Autumn – Spring, 1984): 74-77.
[19] *Ibid.*, 75.

full-length essay in Spanish or English has examined Boot's flood control proposal for Mexico City. Understandably, Boot is not well-known. In this chapter I hope to shed light on Boot and his ideas for water management.

A Biographical Sketch

Very little is known about Adrian Boot's life in Mexico City. Even less is known about the Dutch engineer prior to his arrival in Mexico until now. Based on archival documents located in the Archivo General de la Nación, Mexico's national archives, I have been able to reconstruct some of his biography. Boot was born in the city of Delft, which is located in the southern province of Holland.[20] According to the *Nieuw Nederlandsch Biografisch Woordenboek* (*New Dutch Biographic Dictionary*), Boot's parents were Cornelius Boot and Sophia van Wijck.[21] He had an older brother of the same name who was a canon in the city of Doorn, who died in 1591.[22] At the age of eleven or twelve, Boot and his family left Holland for France to live in the city of Troyes.[23] Later in life, Boot worked as a hydraulic engineer for Count Maurice of the French Mediterranean city of Marseille for a period of six years.[24] From the *Relación universal* and archival documents, we know that Boot also drained lakes in Flanders and Germany.[25] Unfortunately, his hydraulic works in Europe have not withstood the test of time and are little-known to historians of French and Dutch water management.[26]

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[20] AGN: Indiferente Virreinal, caja 5574, exp. 057, f. 1; AGN: Indiferente Virreinal, caja 0837, exp. 004, f. 8.
[21] http://www.
historici.nl/retroboeken/nnbw/#page=115&accessor=accessor_index&source=4&accessor_href=accessor_index%3FSearchSource%253Autf8%253Austring%3DBooth&view=imagePane; Accessed June 10, 2011.
[22] *Ibid.*
[23] AGN: Indiferente Virreinal, caja 5373, exp. 049, f. 1.
[24] AGN: Indiferente Virreinal, caja 0837, exp. 004, f. 11.
[25] *Relación universal*, 114, 143, and 323; AGN: Indiferente Virreinal, caja 0837, exp. 004, f. 78v.
[26] Perhaps just as telling about Boot is the difficulties I have encountered in finding information regarding his hydraulic work in Europe. Despite countless email exchanges with historians of Dutch and French hydraulics, they were unable to shed light on Boot. This is not a criticism of these scholars, but rather an indication of Boot's place in

The *Dictionary* also notes that Boot eventually returned to the Netherlands after being in New Spain and married Margaretha Voskuyl. He became a captain and later mayor of the city of Utrecht and died on May 18, 1638.[27] Yet archival documents located in the Archivo General de la Nación tell a different story. In New Spain, Boot was married to María del Monte.[28] In testimony provided to the Inquisition, on October 16, 1637, Boot mentions having five sons and four daughters.[29] In 1632, we learn the names of three of his daughters when he wrote that maintaining two homes (one in Mexico City and another in San Juan de Ulúa) was a financial burden, and as a result, he would send for his family.[30] The names of his wife and daughters are listed in the marginalia. Beside his wife María, his daughters Luisa, Isabel, and Juana are listed. A Luis Ángel Platero is also listed, with no indication as to his relationship to Boot. The fourth daughter is located in a petition of February 19, 1676 to the Inquisition. Flora del Monte states she was the legitimate daughter of Adrian Boot and María del Monte and one of eight siblings.[31] Unfortunately, Flora said nothing about her brothers. From archival documents, we also know that Boot did not pass away in the Netherlands in 1638 as offered by the *New Dutch Biographic Dictionary*. In April 1644, Boot was locked away in a secret cell being investigated by the Inquisition.[32] The date of Boot's death is still a matter for historical detective work, but it has been suggested he passed away in Mexico City around 1648.[33]

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the history of European hydraulics. The obscurity of Boot leads me to believe he had a less than significant role in Europe. This fact does not diminish the value of his proposal at Mexico City. Perhaps the New World, much as with painters in viceregal Mexico, afforded Boot opportunities that were not readily available to him in Europe.

[27] http://www. historici. nl/retroboeken/nnbw/#page=115&accessor=accessor_index&source=4&accessor_href=accessor_index%3FSearchSource%253Autf8%253Austring%3DBooth&view=imagePane.

[28] AGN: Indiferente Virreinal, caja 0837, exp. 004, f. 101v.

[29] *Ibid.*, f 107.

[30] *Ibid.*, f. 79v.

[31] *Ibid.*, f. 101v.

[32] AGN: Indiferente Virreinal, caja 6648, exp. 011, f. 1-1v.

[33] José Omar Moncada Maya, *Ingenieros militares en Nueva España: inventario de su labor científica y espacial, siglos XVI a XVII* (Mexico City: Instituto de Geografía, Universidad Nacional Autónoma de México / Instituto de Investigaciones Sociales, 1993), 22.

A Royal Search for a Hydraulic Engineer

By 1612, word of Martínez' *desagüe* and its shortcomings had reached the Spanish monarch Philip III. Obviously concerned with the dangers that flooding posed to Mexico City, an international search for a hydraulic engineer was initiated. On May 29, 1612, Philip wrote his ambassador to France, Iñigo Cárdenas, requesting that he search for an engineer versed in geometry and the weight and measurement of water.[34] With surprising speed Cárdenas identified Boot, who was already working in France, and on July 29, 1612, the ambassador wrote to Philip recommending the Dutch engineer.[35]

A map accompanied Cárdenas' letter of recommendation. Made by Boot more than two years before ever setting foot in the Spanish New World, *Diseño de la Ciudad de México y del virreinato de Nueva España desde el mar del Norte al del Sur, para instrucción del desagüe de la laguna de México* describes cartographically the geographical terrain of the city within central Mexico (Fig 1). It is no more than a schematic drawing that suggests a general understanding of Mexico City within the volcanic terrain between the Pacific Ocean and the Gulf of Mexico. Boot depicted the city within a large circular body of water, and in a reddish hue, illustrated the causeways that linked the island city to the mainland. Encircling the lake are the mountains and volcanoes that make up the walls of the Basin of Mexico. On the western and eastern flanks of the basin are two rivers, the Guadelia and Panuco, leading, respectively, to the Pacific Ocean (to the left) and the Gulf of Mexico (to the right). The latter is significant since it was key to Martínez' plan to drain the lakes into the Gulf via this river. Yet with only his vague knowledge of the region, Boot was unable to describe visually how drainage would actually occur. This uncertainty is most present in the varying degrees of detail offered in the map. On the one hand,

[34] Cepeda, Carrillo, and Serrano, *Relación universal*, 114 and 143; Mayer, "Trasmonte y Boot," 186.
[35] Mayer, "Trasmonte y Boot," 186.

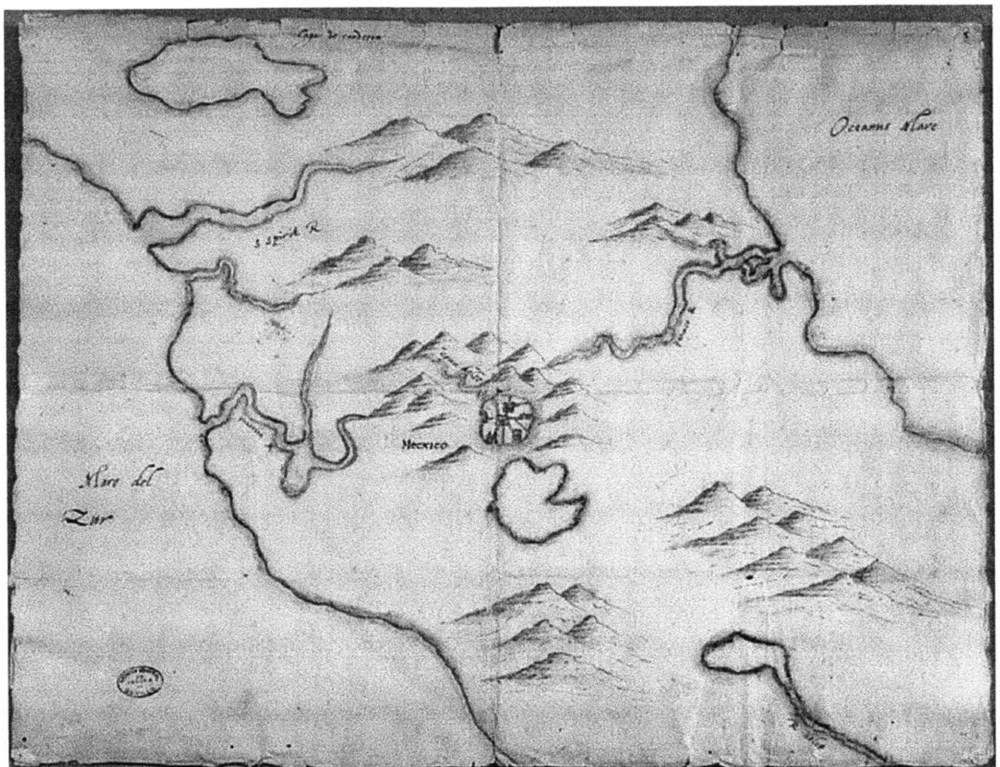

Figure 1. Adrian Boot, *Diseño de la Ciudad de México y del virreinato de Nueva España desde el mar del Norte al del Sur, para instrucción del desagüe de la laguna de México*. Pen and ink drawing, 33 x 42 cm. Source: Archivo General de las Indias, Mexico no. 55.

Boot had a general grasp of the overall geography of the region, but on the other, this understanding was lacking when describing how the rivers relate to the basin. This ambiguity demonstrates that Boot lacked the specific knowledge about this geographical relationship needed to provide a more detailed account of how to breach the basin. As a result, the emphasis given to the Panuco River in line weight and color nearest the Gulf diminishes further inland, and all but disappears when reaching the walls enclosing Mexico City. Surprisingly, not even Martínez' *Descripción de la comarca de México i obra del desagüe de la laguna* portrayed drainage as a problem beyond the walls of the basin. Boot's map offered to Philip a general understanding of the region's hydrographic condition that must have impressed the monarch since Boot had never seen the viceregal capital. Surely, Boot's map did not detract from Cárdenas' recommendation.[36]

Eventually, Boot traveled to Spain where he negotiated a monthly salary of 100 ducats, an extraordinary sum that was only comparable to the highest-paid judges in Spain.[37] On June 1, 1613, Philip wrote the New Spanish Viceroy Diego Fernández de Córdoba, 1st Marqués de Guadalcázar to announce Boot's impending arrival.[38] Boot was to set sail July 1 for New Spain under the guidance of captain general Antonio de Oquendo but for unknown reasons he never joined the fleet.[39]

The Shortcomings of the *Desagüe*

Boot finally arrived at Mexico City in November 1614. On November 17, along with Martínez, Pedro de Otalora, and a notary, among others, he began surveying the geographical terrain of the city and lakes, causeways and dikes, and not least, the *desagüe*.[40] To demonstrate to the Dutch engineer how it performed, Martínez opened the floodgates, allowing water to flow through the canal and tunnel, eventually seen exiting at the mouth of Nochistongo.[41] Despite the success of the demonstration, Boot soon noticed that many of the pre-Columbian hydraulic structures were in need of repair; but perhaps his greatest concerns involved Martínez' earthwork project.[42] The *desagüe* was to drain the lacustrine environment primarily by using gravity, but Boot found this simply impossible. The mouth of the *desagüe* canal was higher in elevation than

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[36] *Ibid.*
[37] AGN: Inquisición, vol. 383, exp. 10, f. 18; Cepeda, Carrillo, and Serrano, *Relación universal*, 114. See also Rodríguez-Sala, *Letrados y ténicos de los siglos XVI y XVII*, 271.
[38] Cepeda, Carrillo, and Serrano, *Relación universal*, 114. Among other information, the *cédula* apprised the viceroy that Boot came highly recommended by Cárdenas.
[39] *Ibid.*, 114-115.
[40] *Ibid.*, 117-119.
[41] *Ibid.*, 118.
[42] *Ibid.*,117-119; Hoberman, "Technological Change in a Traditional Society," 284; Rodríguez-Sala, *Letrados y ténicos de los siglos XVI y XVII*, 151.

where the Cuautitlán River entered Lake Zumpango.[43] Not to take into account this discrepancy in height was an obvious mistake, but perhaps the most egregious error in surveying was noticed when it was discovered that the mouth of the *desagüe* tunnel was 11.7 meters higher in elevation than Lake Mexico.[44] Draining Lake Mexico was essential to the success of the *desagüe* as noted by the architect Alonso Arias on May 8, 1611.[45] Without the aid of machines to pump water uphill, Martínez' plan would have limited success at Lake Zumpango and be completely ineffective at Lake Mexico, thus offering no resolution to the city's flood concerns.

Another shortcoming of the *desagüe* was the tunnel's cross-sectional area in relation to the Cuautitlán River. Boot deduced that its 13.61 square meters was significantly under-designed for the 43.57 square meters of the river's cross-sectional area. Simply put, the Cuautitlán would still overflow the lakes since the tunnel could only drain less than one-third of its water, if all conditions were optimal; however, they were not. In reality, the latter figure does not represent the tunnel's true capacity: floodgates reduced its area by more than one-half to a mere 5.4 square meters.[46] Other issues made the *desagüe* even less effective: the tunnel and canal lacked the necessary slope to drain the waters; the tunnel required structural reinforcement for much of its span; and filters were needed to prevent debris from entering the tunnel and causing damage.[47] Remedying the shortcomings of the *desagüe* might have seemed like the most reasonable solution to the surveying and engineering issues at hand. Yet Boot flatly rejected the drainage plan as an answer to the city's flood problems, arguing that it would never liberate the city from catastrophic inundation.[48]

[43] Rodríguez-Sala, *Letrados y ténicos de los siglos XVI y XVII*, 151.
[44] Cepeda, Carrillo, and Serrano, *Relación universal*, 143.
[45] Mathes, "Enrico Martínez of New Spain," 72.
[46] Cepeda, Carrillo, and Serrano, *Relación universal*, 144.
[47] *Ibid.*,126.
[48] *Ibid.*

Boot's Other *Desagüe*

Boot's dismissal of the drainage approach is ironic. After all, the Spanish ambassador to France chose Boot for his expertise in draining lakes.[49] Boot had also worked on drainage projects in the Netherlands and Germany, and produced *Diseño de la ciudad de México y del virreinato de Nueva España desde el mar del Norte al del Sur, para instrucción del desagüe de la laguna de México* in support of drainage to obtain his commission from Philip.[50] Furthermore, an Inquisitional testimony penned by the Dutch engineer on October 16, 1637 reveals his role in a second and little-known drainage project. According to the declaration, officials from Zacatecas sent a person by the name of Rogos to Mexico City. The purpose of the visit was of great importance to the Zacatecan mining industry. A shortage of salt, which was key for extracting silver from silver ore, caused its price to rapidly increase. In the wake of this shortfall, speculators drove the price of sea-salt, which was brought from the gulf coast town of Tampico, to the exorbitant amount of 17 *pesos* per bushel. Rogos, an expert in draining mineshafts, approached Viceroy Guadalcázar with a plan to bypass the Tampico salt trade by harvesting a local supply. The visitor identified the three salt-water lakes of Santa María, Santa Clara, and Saldiver as a possible source. However, obtaining the much-needed mineral necessitated drainage.

Salt extraction from lakes requires them to be shallow for the process of evaporation to take effect—allowing the sun's rays to penetrate deep enough to crystallize the salt minerals. But the Zacatecan lakes were full, making harvesting the sodium chloride difficult. Rogos' plan consisted of draining the Santa María and Santa Clara into the Saldiver via a canal.[51] Guadalcázar viewed the project as too important to New Spain's silver industry to be left in the

[49] *Ibid.*,143.
[50] *Ibid.*, 114, 143, and 323; AGN: Indiferente Virreinal, caja 0837, exp. 004, f. 78v.
[51] AGN: Indiferente Virreinal, caja 0837, exp: 004, f. 108v.

hands of a distant stranger, and placed Boot in charge of the project. After traveling to Zacatecas to inspect the lakes, the Dutch engineer supervised the construction of a canal 5 meters wide by 3.7 meters in depth to drain the Saldiver, allowing him to then lower the water levels of the Santa María and Santa Clara lakes by using the Saldiver as a "storage tank" for their water.[52] As Rogos had proposed, the natural process of evaporation allowed salt crystals to form from the salt-water lakes. The project was a success, according to Boot's declaration that, the following year, the price of a bushel of salt plummeted to the very affordable two-and-one-half *reales* from its speculative high of 17 *pesos*.[53] More importantly, the cost of Boot's *desagüe* was the paltry sum of 580 *pesos* compared to the thirty-two thousand proposed by Rogos.

Clearly, Boot's hydraulic projects in Europe and in Zacatecas demonstrate that he was not inherently against drainage. Significantly, he came from a country where drainage was part of everyday life, having played an important role not only in flood control and agricultural production, but also in land reclamation. Yet, if drainage was not an ideological issue, are there other reasons why Boot dismissed Martínez' *desagüe*?

Boot's Water Management Proposal for Mexico City

On January 27, 1615, Boot presented an alternative plan to Martínez' *desagüe*.[54] He began his proposal by arguing passionately for the "instruments of [his] art"—the profession of hydraulic engineering—and unapologetically avowed that they would "catch" and "cast out" any water that threatened Mexico City, and that they would work hand-in-hand with canals to prevent flooding—a practice he likened to the water management practices in the Low

[52] *Ibid.*, f. 108v-109.
[53] *Ibid.* Eight *reales* is equivalent to one *peso*, meaning that the speculative high of salt reached 136 *reales*.
[54] Mathes, "Enrico Martínez of New Spain," 73.

Countries.[55] He proposed to contain and regulate the lakes by fortifying existing dikes and causeways, and building a dike around the western side of the island settlement, eventually connecting with the dike of San Lázaro. Essentially, the Dutchman proposed a protective ring around the city. In addition to this defensive circle, the water level within it was to be regulated by canals, drainage windmills and pumps, and dredges.[56] Specifically, Boot called for reinforcing the pre-Columbian causeway of Chiconautla to hold back the waters from the lakes of Zumpango and Xaltocan, and any runoff originating from the Pachucan mountain range; for repairing the upper half of the dike of San Lázaro; for fortifying the causeway of San Antón (known as the causeway of Iztapalapa in Aztec times); for building a canal 10,894 meters long by 6.7 wide by 3.3 deep from the causeway of San Antón to the Guadalupe River; and for constructing four smaller canals, from this newly-built larger canal, that would provide the city with fresh water and avenues for transportation.[57] His design also called for building twenty floodgates; fourteen *overtooms* (boat ramps); seventy bridges; two large "instruments"; and requisitioning a variety of tools.[58] Specifically, Boot called for 410 metal shovels; 80 wooden shovels; 50 metal picks; 112 metal and wooden tools of various sizes; 60 metal tools for cleaning canals and pools of standing water; 80 leather buckets; and 70 hoes. As important to the success of the plan, Boot requested 150 Indians for constructing the project, who would labor under the guidance of eight overseers.[59] Work was to begin in October 1615 and to be completed in three years' time.[60]

As one can imagine, Martínez strongly disagreed with Boot. But it would be years before it would become evident how great his distrust was for the Dutch engineer. In a report penned in

[55] Cepeda, Carrillo, and Serrano, *Relación universal*, 126.
[56] Hoberman, "Technological Change in a Traditional Society," 284.
[57] Cepeda, Carrillo, and Serrano, *Relación universal*, 126-127.
[58] *Ibid.*, 127-129.
[59] The native labor force was to work for nine months out of the year for three years.
[60] Cepeda, Carrillo, and Serrano, *Relación universal*, 127.

1623 on the *desagüe*, Martínez charged Boot with being an imposter.[61] The German cartographer questioned Boot's abilities in mathematics, geometry, architecture, science, and all other faculties essential to the profession of hydraulic engineering. He argued that cleaning canals, dredging rivers, and raising the height of dikes and causeways were such simple tasks that the Indians performed these to control flooding.[62] Clearly, Martínez expected a more sophisticated plan from an engineer recommended by the king—one that did not resemble Indian flood control practices. However, Martínez failed to comprehend that each method had developed independently and that key differences existed between the two. Despite the commonalities of each approach—canals, dams, and dikes, and the cleaning and dredging of waterways—Boot's method was based on Dutch water management practices implemented at home and exported to other European countries.[63] Significantly, Boot's dependence on machines—chiefly drainage windmills, dredges, *overtooms*, and pumps—differs from any of the pre-Columbian undertakings.

Boot also produced a manual of these devices.[64] One possible reason for the production of the manual was that city officials could easily conceive how dikes, canals, and floodgates functioned since they formed part of the existing hydraulic landscape. However, the machines Boot proposed were foreign and their unfamiliarity could have posed obstacles in gaining the approval of city officials. Like so many of the maps of early *desagüe* proposals, the location of the manual is unknown. Historian of the *desagüe* Louisa Schell Hoberman has correctly noted

[61] AGN: Desagüe, vol. 3, exp. 1, f. 5v.
[62] *Ibid.*
[63] For an understanding of the Dutch hydraulic influence on their European neighbors, see Helga S. Danner, J. Renes, B. Toussaint, P. van de V. Gerard, and F. D. Zeiler, ed., *Polder Pioneers: The Influence of Dutch Engineers on Water Management in Europe, 1600-2000* (Utrecht: Koninklijk Nederlands Aardrijkskundig Genootschap and Faculteit Geowetenschappen Universiteit Utrecht, 2005).
[64] Cepeda, Carrillo, and Serrano, *Relación universal*, 129.

that Boot's proposal drew from Dutch hydraulic practices used in drying inland lakes.[65] But as we know, Boot was adamantly against drainage at Mexico City. Although he proposed Dutch drainage technology, he did not intend to use it in a similar manner. Key differences in the social and environmental character of Mexico City prevented the wholesale transfer of these European hydraulic practices to the New World. Boot understood the differences, and equally important, the value of water to the city. Indeed, Martínez was also not blind to the relationship between water and city, as he noted the invaluable service that canoes provided in ferrying supplies to the city.[66] For Martínez, however, solving the problem of flooding far exceeded any advantages the lakes provided the city, and equally significant, any of the environmental consequences brought about by drainage.

European Drainage and Capital Investment

Mexico City's bond to the lakes was not always one of imminent disaster, as the proponents of drainage seemed to believe. Despite the colonial floods of 1555, 1580, 1604, and 1607 and their disruption to colonial life, the lacustrine environment was of great benefit to the city. Water helped to frame the city's architectural character, supported the region's agricultural production and canoe transportation, and was also a source of income for Indians. Unlike European hydraulic projects where the social and economic benefits many times stemmed from complete drainage, the opposite was true at Mexico City. In Europe, generally speaking, drainage was part of capital investment.[67] The drying of inland lakes formed part of speculative projects that reclaimed land for agriculture, housing, and animal husbandry; another important

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[65] Hoberman, "Technological Change in a Traditional Society," 284.
[66] Martínez, "Relación de Enrico Martínez," 2:6.
[67] Salvatore Ciriacono, *Building on Water: Venice, Holland, and the Construction of the European Landscape in Early Modern Times* (New York: Berghahn Books, 2006), 6-9.

reason was the prevention of insect-born disease, as was the case with the swamps of Bordeaux.[68] Capital for these hydraulic works was not provided by a single person or civic entity. Financial partnerships between investors, engineers, and aristocrats were created so no one group would shoulder all of the risk. Conversely, profits were also shared. For example, in France, Dutch investors and engineers readily provided their capital and expertise in return for financial compensation. Investors were entitled to half of all reclaimed land, were exempt from any number of taxes levied by the king, and were allowed to carry arms.[69] Hydraulic engineers received patents of fifteen years for any machine invented during the course of draining a lake, the right to levy a toll on canals constructed, and perhaps, most important of all, were not held liable in case of disaster.[70] In contrast, in Mexico City, engineers were held liable when flooding occurred and could be imprisoned, as was the case with Martínez in 1629. Additionally, European-style financial partnerships and incentives to participate in drainage were non-existent in the *desagüe*. In fact, drainage was not viewed in terms of entrepreneurship, but rather as a municipal-led enterprise. The *desagüe* was truly a public works project.

The Benefits of Water

The benefit of the lakes to the city was central to Boot's rejection of the *desagüe* and formed the basis for his own proposal. Draining the lakes would adversely affect the city's food supply, since without water the agricultural *chinampas* would become barren. The relationship between the lakes and the city's food supply was not lost on Boot, when in a later proposal of 1620, he argued for the preservation of the lakes.[71] Canals were also important hydraulic features

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[68] B. Toussaint, "The Dutch-Flemish Role in Reclamation Projects in France," in *Polder Pioneers*, 125-126.
[69] *Ibid.*, 122-124.
[70] *Ibid.*
[71] Cepeda, Carrillo, and Serrano, *Relación universal*, 145. Boot gave the orchards of Tacuba as an example.

of the aquatic landscape. Not only did they help in regulating lake levels, they also allowed for canoe transportation. Canoes were the primary means of transporting goods and people across the vast lacustrine environment. Although the Spanish introduced beasts of burden and the wheel in New Spain—these were unknown in pre-Cortesian times—they did not bring an end to "traditional" methods of transportation. Quite the contrary: nearly a century after the conquest, not only did Martínez mention their importance for ferrying supplies as previously noted, but Boot, in marked contrast, called for the preservation of the lakes and their waterways given the vital service that canoe and paddler performed. The greatest acknowledgement of the importance of water to the city came not from Boot but from across the Atlantic Ocean. On April 23, 1616, Philip wrote Viceroy Guadalcázar regarding the *desagüe*.[72] On the basis of Boot's arguments, more than likely outlined in correspondence with Philip since the Dutch engineer reported to the monarch directly, the King offered an alternative strategy.[73] Contrary to his earlier wholesale acceptance of drainage, Philip offered a two-prong plan that balanced drainage with regulation. The monarch proposed that the Cuautitlán River, the lakes of Zumpango, Xaltocan, and San Cristóbal, and the water from the Pachucan mountain range be drained, as these posed the greatest threat to the city.[74] But in what may be considered a partial victory for Boot, Philip directed that the other lakes and the rivers of Chalco, Guadalupe, and others, were of great benefit and should remain, stating that Mexico City should always have the water it required.[75] Surely, any plan that acknowledged the value of water, especially one championed by the King, must have been a professional disappointment to Martínez and a victory for Boot.

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[72] AGN: Desagüe, vol. 3, exp. 1, f. 8-8v. For the published version of Philip's letter, see Cepeda, Carrillo, and Serrano, *Relación universal*, 146-148.
[73] I would like to thank Roberto L. Mayer for bringing to my attention that Boot reported directly to Philip.
[74] AGN: Desagüe, vol. 3, exp. 1, f. 8.
[75] AGN: Desagüe, vol. 3, exp. 1, f. 8. Specifically, Philip mentioned the value water to canoe transportation.

Until now, we have scrutinized the reasons why Boot rejected the *desagüe*, but what would be the character of the city if Dutch hydraulic technology were implemented as a flood control measure in the New World? Fortunately, we have a map that represents the most significant aspect of Boot's water management plan.

A Map of the Basin of Mexico

In 1699, the Italian traveler Giovanni Francesco Gemelli Careri published *Giro del mondo*, a six-volume account of his five-year travels that spanned the globe.[76] The last volume contains a map of the Basin of Mexico, *Hydrographicamelo Mexicano rappresentato nelle sue Lacune* (Fig. 2). Gemelli Careri advises his readers that he is not the author of the map. Instead, he attributed it to Adrian Boot, who he refered to as "ingenious." The Italian traveler also alerts his readers that his map is not a direct copy from Boot's original, but rather is based on a copy presented to him by Cristóbal de Guadalaxar. According to Gemelli Careri, Guadalaxar was a "good mathematician" and with great care had made a copy of Boot's map because it was in a state of deterioration.[77] The map depicts the Basin of Mexico, identifying towns and rivers, the lacustrine environment, and the island of Mexico City. Perhaps surprisingly, it also identifies the *desagüe* and its path in the lower left-hand corner of the map. Yet, what is most striking is the portrayal of the city in relation to Martínez' *Descripción de la comarca de México i obra del desagüe de la laguna.* Recall that in Martínez' map, Mexico City stands as cartographic symbol. This seemingly innocent detail is revelatory of Martínez' understanding of the city and its

[76] Giovanni Francesco Gemelli Careri, *Giro del mondo*, 6 vols. (Napoli: Guiseppe Roseli, 1699-1700).
[77] Gemelli Careri, *Giro del mondo*, 6:59. Due to its condition in the late seventeenth century, Boot's original may no longer exist today.

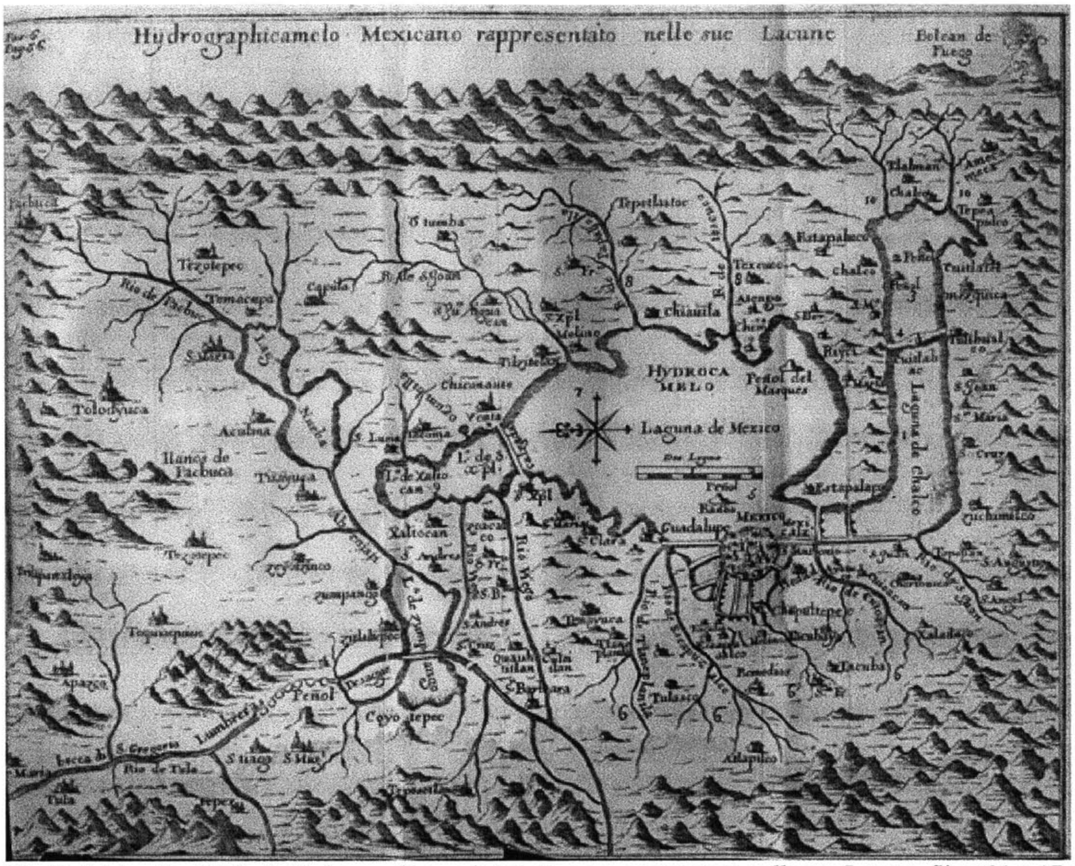

Fig. 2. Adrian Boot (after), *Hydrographicamelo Mexicano rappresentato nelle sue Lacune*. Size: 21 x 17 cm. Photograph courtesy of The Newberry Library, Chicago. Collection No. Ayer 124. I88. G2 1699. Vo. 6.

relation to the lakes as previously explained. Recall that the city is independent of its aquatic surroundings, since iconographically it resembles mainland structures. A completely differentmanner of describing the city and the lakes is seen in *Hydrographicamelo Mexicano rappresentato nelle sue Lacune* (Fig. 3).[78] For instance, we find the city represented as a series of buildings and open spaces in circular fashion, as if protecting itself from the outside world. The orbicular organization is strikingly similar to Boot's proposal of building a dike encircling the city to protect it from disaster; we can easily distinguish a hydraulic network cradling the city.

[78] Connolly and Mayer briefly noted the cartographic differences between Boot and Martínez in depicting Mexico City. Consult "Vingboons, Trasmonte and Boot," 56-57.

Fig. 3. Mexico City (after), *Hydrographicamelo Mexicano rappresentato nelle sue Lacune* (Detail).

As series of causeways connect the island to the mainland. This map thus demonstrated how the viceregal capital of Mexico City is represented as an island, conceived in relation to the lacustrine environment.

Dutch Hydraulic Technology

When Boot rejected the *desagüe*, he was clearly against drainage at Mexico City. Draining the lakes would have adversely affected the city and region. Yet the problem of flooding still remained, and required a solution. For Boot, flooding was not an issue of water, but rather its excess. In this respect, Boot had arrived to similar conclusion as Gudiel. The Dutchman's proposal sought to balance the city's dependence on the lakes while simultaneously preventing inundations. Not unlike the Aztec, Boot proposed to build hydraulic structures: dikes, canals, and floodgates that would work in unison to regulate the lakes. However, this was not the only way the Dutch engineer intended to prevent inundation. In his proposal, Boot stated he would "catch" and "cast out" any water that threatened the city. Boot called for a two-part flood-control plan. His first line of defense was to contain and regulate the lakes and if regulation was insufficient, he would put into action the "instruments of his art" to defend the city from any encroaching waters.

Along with improving the existing hydraulic network, Boot proposed to build a mega-dike encircling the city for its protection. Floodgates would regulate the water level within this shielded precinct by maintaining a "healthy" amount for the benefit of the city. When water levels were low, the gates would be opened to allow Lake Mexico to spill into the area, but when flooding was imminent, they were to be closed. Closing the gates would obviously prevent water from entering, but it would also prohibit canoe access, and stop the daily supply of provisions to the city, bringing the viceregal capital to a halt. Not unknown to Boot were *overtooms*, as they were the preferred method in the Low Countries for moving boats over dikes (Fig. 4).[79] At one end, a rope is attached to the boat; at the other, the rope is anchored to a rotating beam with wheel or spokes on each end resting on an A-frame or stout column. A person would turn the wheel, making the rope taught between the boat and the rotating beam, and pull the canoe over the dike. In this manner, Boot could supply the city with its daily provisions with the floodgates closed.

Unable to prevent the process of silting, given the changes in land-use triggered by the Spanish, Boot offered to remove this dangerous sediment with dredgers. These machines are depicted in Jacques Besson's *Theatrum instrumentorum et machinarum* of 1578, of which a copy

[79] Hoberman has suggested that cranes would transport canoes from one side of a dike to another when conditions prevented opening the floodgates. See the 1980 version of "Technological Change in a Traditional Society," 401. However, the Dutch preferred *overtooms* or boat ramps. Boat ramps required little technological innovation in comparison to the cranes, a fact that would have made considerable more sense to viceregal authorities who depended on Indian manual labor.

Fig. 4. *Overtoom*. Photograph courtesy of Anton Haddeman, Portage at the 'Blauwe Molen,' Getty Images.

was found in Boot's library when arrested by the Inquisition (Fig. 5).[80] This particular dredger is a double-winch device where two men on land pull towards them a raft composed of four barrels, a platform, and another winch. On the raft, two men drag to them, with the aid of the second winch, a concave "basket." This basket, scraping the bottom of the lakes, would scoop up any silt, and thus prevent water levels from rising. If the water level within this protective zone endangered the city, windmills, Boot proposed, would remove the excess water. Strikingly, Boot failed to mention them in his proposal. Yet, from Martínez' criticism of the Dutch engineer's plan, we know that Boot intended to use *molinos de viento* to control flooding.[81] For any early modern Dutch hydraulic engineer, drainage windmills were not novel devices: they had existed

[80] AGN: Inquisición, vol. 383, exp. 10. Jacques Besson, *Theatrum instrumentorum et machinarum... Cum Franc. Beroaldi figurarum declaratione demonstratiua* (Lugduni: Apud Barth. Vincentium, 1578).
[81] AGN: Desagüe, vol. 3, exp. 1, f. 4v.

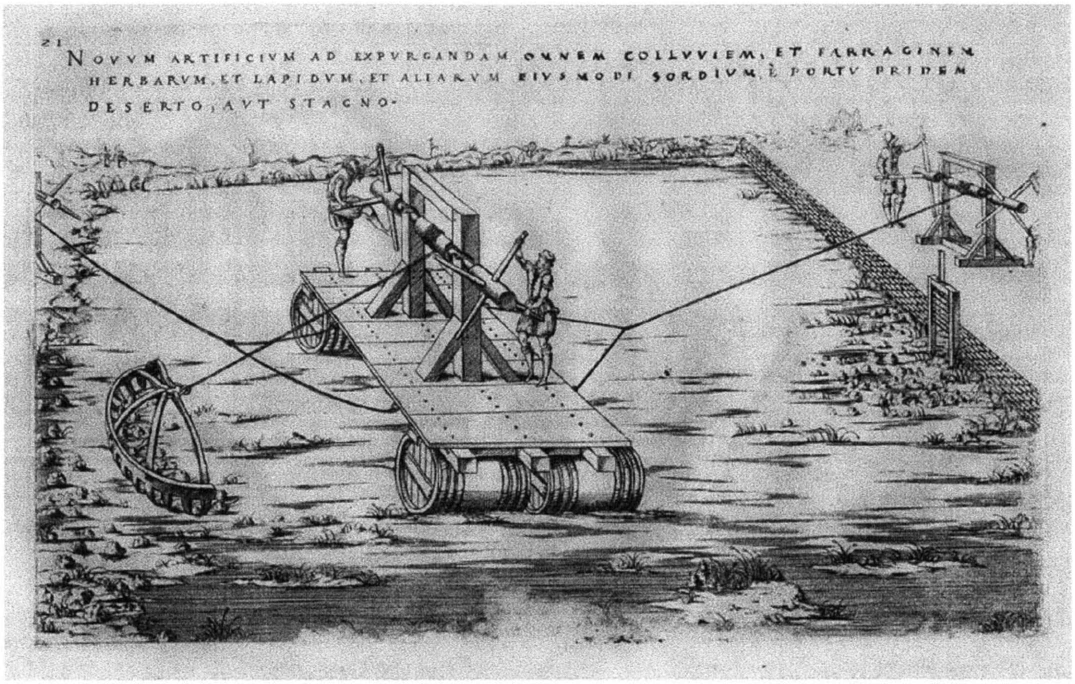

Fig. 5. Jacques Besson, *Dredger*, 1578. Photograph courtesy of The Newberry Library, Chicago. Collection No. Wing FZP 539 v74, Plate 21.

in the Low Countries as early as 1408.[82] The earliest drainage windmills used the "traditional" scoop wheel to lift water, but were limited in their "effective lift" to one-third or less of the wheel's diameter (Fig. 6).[83] In the sixteenth century, the Archimedean screw began replacing the waterwheel and immediately had a significant impact in the lifting of water (Fig. 7).[84] The difference in lift went from between 1. 5 and 2 meters for a waterwheel and up to 4 meters for the Archimedean screw, which gave it a significant advantage over the scoop wheel. Yet, to gain its advantages in the lifting of water, it required a more skilled millwright to construct it, since it

[82] Arne Kaijser, "System Building from Below: Institutional Change in Dutch Water Control Systems," *Technology and Culture* 43, no. 3 (Jul., 2002), 531-532; Petra J. E. M. van Dam, "Sinking Peat Bogs: Environmental Change, 1350-1550," *Environmental History* 6, no. 1 (Jan., 2001), 37; Ciriacono, *Building on Water*, 162; and Johan van Veen, *Dredge, Drain, Reclaim: The Art of a Nation*, 5th ed. (The Hague: Martinus Nijhoff, 1962), 42-43.
[83] Richard Leslie Hills, *Power from Wind: A History of Windmill Technology* (Cambridge; New York: Cambridge University Press, 1994), 117-118; John Reynolds, *Windmills and Watermills* (New York: Praeger Publishers, 1970), 140.
[84] Ciriacono, *Building on Water*, 162 and 178.

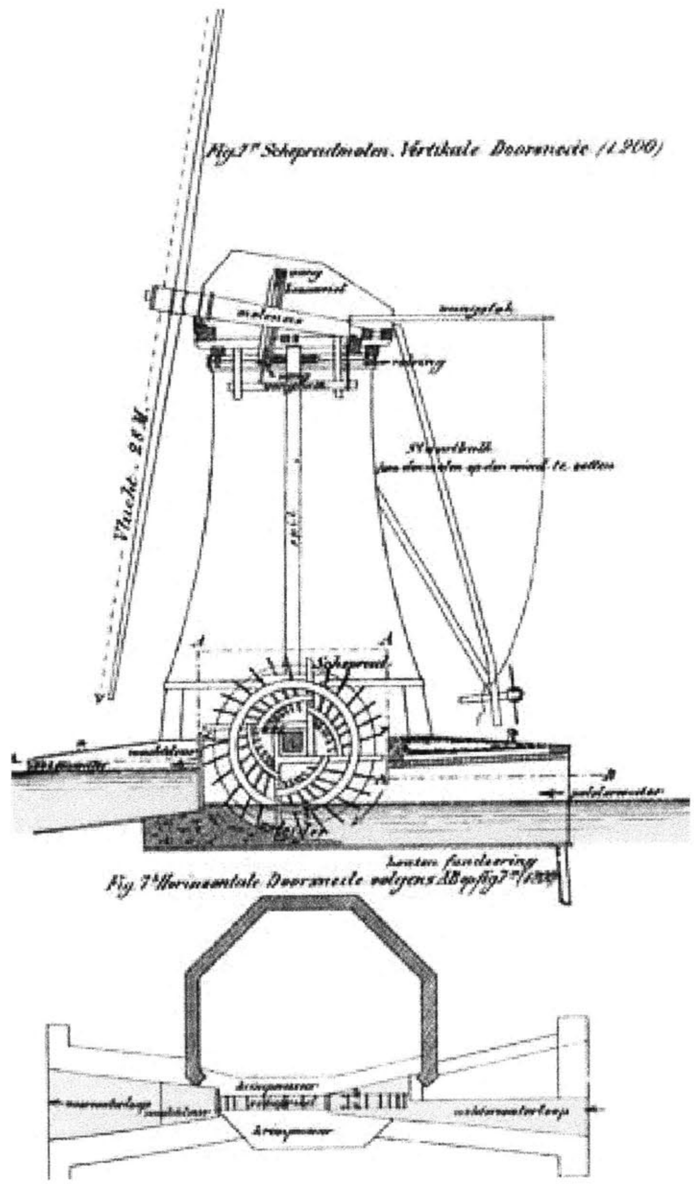

Fig. 6. Scoop Windmill.

was built from many small pieces of wood that were mortised together at a continuous angle as it rotated around a central wooden shaft.[85] The Archimedean screw is made of a "continuous spiral chamber formed around an inclined central shaft" and with the rotation of the shaft water was

[85] Hills, *Power from Wind*, 119.

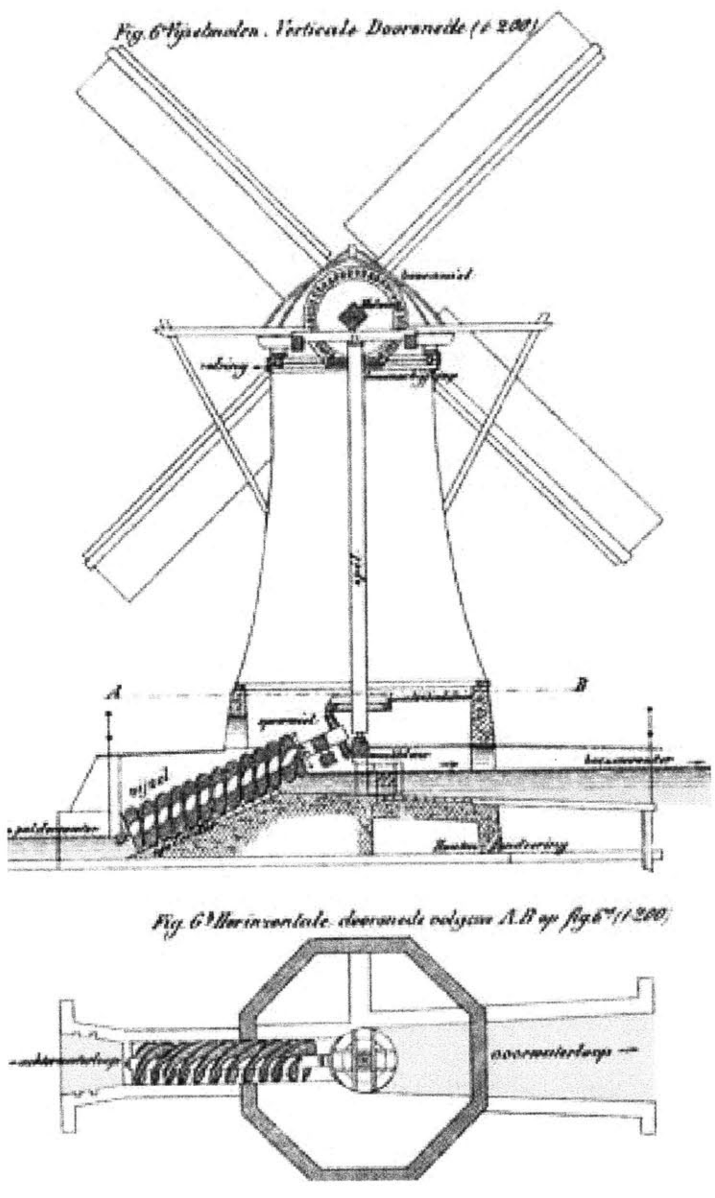

Fig. 7. Archimedean Screw Windmill.

drawn up, exiting on its upper end.[86] In 1589, Cornelis Dirckszoon Muys designed a windmill with a rotating cap.[87] Until this point, it was necessary to turn the entire mill into the wind to

[86] Reynolds, *Windmills and Watermills*, 144.
[87] Ciriacono, *Building on Water*, 162.

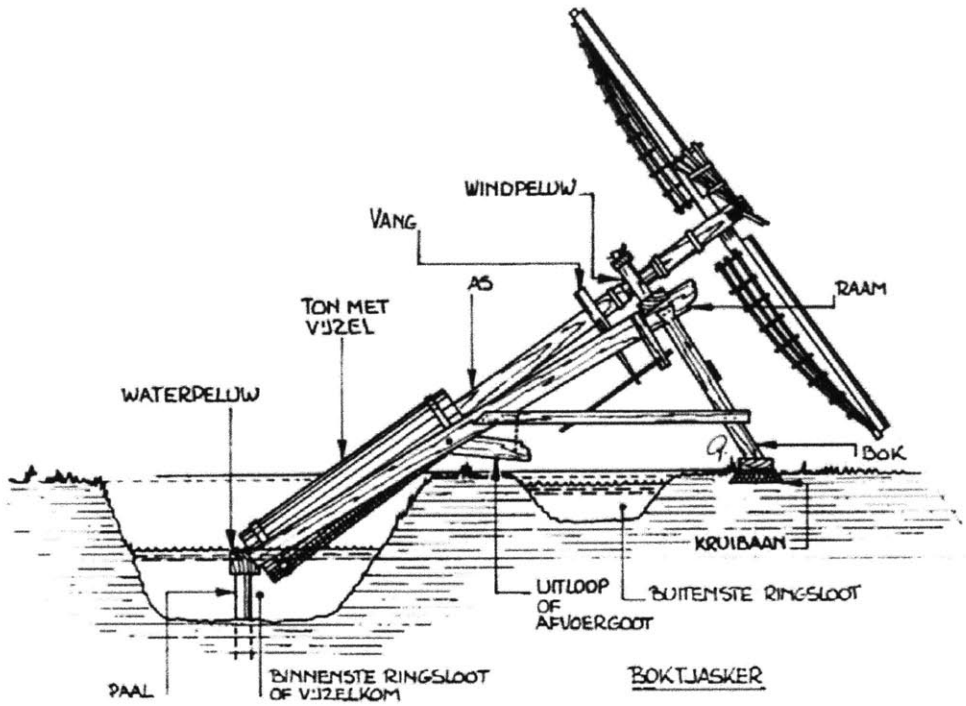

Fig. 8. *Tjasker*. Source: http://www.ebedejong.nl/tjasker.htm. Consulted March 12, 2012.

harness its energy. With the invention of the rotating cap, the windmill became a fixed structure of steady construction—two features that its predecessor (the post mill) had lacked, which made it susceptible to being blown over.[88] Another characteristic of the windmill was the double curved surface of its sails, allowing for a favorable "angle of incidence to the relative wind at any radial distance."[89] In Europe, windmills were impressive architectural structures designed to house complex machinery, and at times, the millwright and his family, rising six and seven stories.[90] Windmills were expensive to build and maintain, and surely would not have been viewed favorably by the fiscally conservative officials of Mexico City.

[88] Gerard Doorman, *Patents for Inventions in the Netherlands during the 16th, 17th, and 18th Centuries, with notes on the Historical Development of Technics*, trans. Joh Meijer (The Hague: Martinus Nijhoff, 1942), 79.
[89] *Ibid.*
[90] Alison McNeil Kettering, "Landscape with Sails: The Windmill in Netherlandish Prints," *Simiolus: Netherlands Quarterly for the History of Art* 33, no. ½ (2007/2008), 69.

Perhaps, Boot proposed a more economical version that maintained all the essential features of the drainage windmill. The *tjasker*, which can be traced to Frisian manuscripts as early as 1580, might have provided Boot with a machine that was less expensive to build and maintain since it required significantly less material, labor, and expertise (Fig. 8). It is composed of four sails mounted to one end of a wind shaft (supported by an A-frame at this point), which extended at a downward angle to form the shaft of an Archimedean screw.[91] Like its more complex counterpart, the *tjasker* also rotated. In this case, the A-frame rested on a circular track so that the sails could always face the wind. The length of this drainage windmill was between seventeen and twenty feet.[92] Compared to its seven-story cousin, the *tjasker* was a simple machine.

The question of whether windmills would have worked at Mexico City requires analysis. Not only is wind velocity key for determining a windmill's capacity, but also important in determining its span, the construction of its sails, the lifting height, and lifting device.[93] A typical seventeenth-century drainage windmill required a wind velocity between 6 and 11 meters per second (m/s; 13.4 and 24.6 miles per hour), and had a span of 25 meters. If the wind velocity were less than 6 m/s, the sails would not turn, and if greater than 11 m/s, the windmill could catch fire due to friction.[94] The specifications to Boot's windmills are unknown and may have been part of the previously mentioned unlocated manual. Wind velocity in early seventeenth-century Mexico City is difficult to establish. Historian Charles Gibson has suggested that not until the 1760's, with the work of Felipe de Zúñiga y Ontiveros and José Antonio Alzate y Ramírez, did the systematic measuring of climatic conditions begin, and that before then only

[91] Hills, *Power from Wind*, 119.
[92] *Ibid.*
[93] G. P. van de Ven, *Man-made Lowlands: History of Water Management and Land Reclamation in the Netherlands*, 4th ed. (Utrecht: Stichting Matrijs, 2004), 182.
[94] *Ibid.*

"casual observations" during "abnormal periods" were noted.[95] A modern-day sample of Mexico City wind velocity (December 19-28, 2011) indicates that enough wind speed exists today to power an early seventeenth-century windmill on two days, and possibly three, of this ten-day period.[96] Using this sample period and assuming that climatic conditions are constant, Boot's windmills would have been idled 75-80 percent of the time. But on the days in operation, they could drain up to 75 cubic meters per minute with an Archimedian screw or 54.7 cubic meters with a paddle wheel.[97] Not all of Boot's drainage devices were dependent on wind as some drainage pumps were animal or human powered.[98]

Boot's Second Proposal and the Problem of Subsidence

On January 28, 1615, Boot received a decision on his proposal from Viceroy Diego Fernández de Córdova.[99] Due to the cost associated with Boot's plan—185,937 *pesos* (not including his salary)—the Dutch engineer's proposal was rejected.[100] On January 31, 1620, five years after his rejection, Boot presented his case to the *cabildo* outlining why regulation and not drainage should be the preferred flood control method.[101] This time, however, he explained the importance of water to Mexico City with regard to subsidence—the process by which soil compacts and the land loses elevation—an approach that was absent from his original proposal. Boot claimed that the loose soil (*tierra floja*, as he put it) of the island would not support the masonry buildings of the Spanish without the aid of water.[102] Clearly, Boot grasped how water functioned as a "raft," holding up the buildings of the Spanish city. Martínez also noted the

[95] Gibson, *The Aztecs Under Spanish Rule*, 303.
[96] http://www. weather. com/weather/tenday/Mexico+City+Mexico+MXDF0132. Accessed December 19, 2011.
[97] Ven, *Man-made Lowlands*, 182.These figures are based on a lifting height of one meter.
[98] Not coincidently, pumps were used in draining the light and airshafts of the desagüe.
[99] Cepeda, Carrillo, and Serrano, *Relación universal*, 130.
[100] *Ibid.*
[101] *Ibid.*, 142.
[102] *Ibid.*, 145.

process of subsidence, but unlike Boot, he believed water caused it.[103] Although both men noted subsidence, Boot's example of the "sinking building" is insightful as it represents an array of problems that drainage would bring. With the *desagüe*, subsidence would take hold. Boot understood this phenomenon all too well since it was a problem that had been associated with drainage in the Netherlands since the late Middle Ages, and one that fueled a never-ending cycle of requiring more drainage as the land subsided, thereby increasing the risk of flooding, which in turn necessitated the pumping of water.[104] At Mexico City, subsidence would work no differently. If the lakes were drained, the soil would compact, effectively making the island sink into the muddy lakebed, which, not unlike in the Netherlands, would increase the risk of flooding, given the city's low elevation in the basin. Subsidence was an issue that Martínez and the drainage proponents failed to fully comprehend, believing that drying of the lakes would end it and thus flooding—a perspective that could not be further from the truth. Boot understood the relationship between drainage and subsidence and how it could actually increase flooding instead of preventing it.[105]

[103] Martínez, *Reportorio de los tiempos e historia de Nueva España*, 181.
[104] Dam, "Sinking Peat Bogs: Environmental Change," 37; Petra J. E. M. van Dam, "Ecological Challenges, Technological Innovations: The Modernization of Sluice Building in Holland, 1300-1600," *Technology and Culture* 43, no. 3 (Jul., 2002), 500-505; and William H. TeBrake, "Land Drainage and Public Environmental Policy in Medieval Holland," *Environmental Review: ER* 12, no. 3 (Autumn, 1988), 84.
[105] Hoberman, "Technological Change in a Traditional Society," 284-285.

Conclusion

Saving Mexico City from flooding was not about rescuing just any settlement from encroaching waters, but rather, securing one of the most important capitals within the broader Spanish colonial enterprise. Philip's international search for a hydraulic engineer, coupled with his (partial) acceptance of Boot's plan for regulation, together speak volumes about the importance of Mexico City to the Spanish crown. The island city was one of only two administrative centers in the Spanish New World at that time—the other being Lima in the Viceroyalty of Peru—a domain that extended from the present-day American Southwest, through Central America, to nearly all of South America. Overseeing the "proper" administration of the Viceroyalty of New Spain required that Mexico City officials have a functioning city to enable them to devote their attention to managing this vast territory, its peoples, and natural resources. Floods proved to be catastrophic interruptions in the political and economic life not just of the island city, but also of the whole Spanish colonial empire. Flooding repeatedly compelled bureaucrats to focus their attention and resources on the restoration of the city after a disaster.[106] Mexico City, without question, required a solution to its centuries-old battle against flooding, and in this sense, the respective approaches offered by Boot and Martínez shared the same goal. However, this is where the commonalities ended.

Martínez sought to end flooding by draining the lakes into the Gulf of Mexico. In marked contrast, Boot proposed to regulate the lakes using Dutch hydraulic technology employed in draining inland lakes, combined with dikes, canals, and floodgates, to maintain a "healthy" supply of water for the benefit of the city. Perhaps not surprisingly, centuries of hydraulic practices in the Netherlands had made Boot aware of how easily the delicate balance between water and land could be altered, and not always for the best. The engineer's proposal shows an

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[106] Hoberman, "Bureaucracy and Disaster."

awareness of how physiography framed Mexico City's hydrographic condition that drainage proponents failed to appreciate, and although he had his supporters, he never received the opportunity to implement his project.

Chapter 5:

In the Midst of Floodwaters

Image-making in the service of water management entered a new phase in 1628 with the bird's-eye view and ichnographic plan (or ground plan) by the Spanish architect Juan Gómez de Trasmonte, respectively titled *Forma y levantado de la Ciudad de México* and *Planta y sitio de la ciudad de México* (Figs. 1 & 2). These drawings signal a new interest in the urban character and form of the city as a function of water management. After a nearly seventy-eight year hiatus since the *Uppsala Map* was made, we have another opportunity to scrutinize the city close up. Yet Gómez de Trasmonte's images are unlike those of his Indian predecessor. While these drawings may be sparked by the desire to end flooding, their character may also be shaped by a different concern in support of water management: taxation. While we lack conclusive proof as to why Gómez de Trasmonte made his drawings, circumstantial evidence suggests that they might have been made to implement a city-wide property tax to help pay for flood control. What is important about this tax is its universal application for the benefit of all who lived on the island. The financial shortfalls that derailed many of the drainage proposals in the sixteenth century may now be an impetus for mapmaking in the early seventeenth century. The shift from producing images for implementing drainage, to making drawings that could (potentially) be used in collecting taxes to pay for flood control, signals a shift in government thinking. It begins to shed light on a new method of government and how its success is dependent on images. Ultimately, devising a method for paying for the *desagüe* was now as indispensible as the technology for draining the basin.

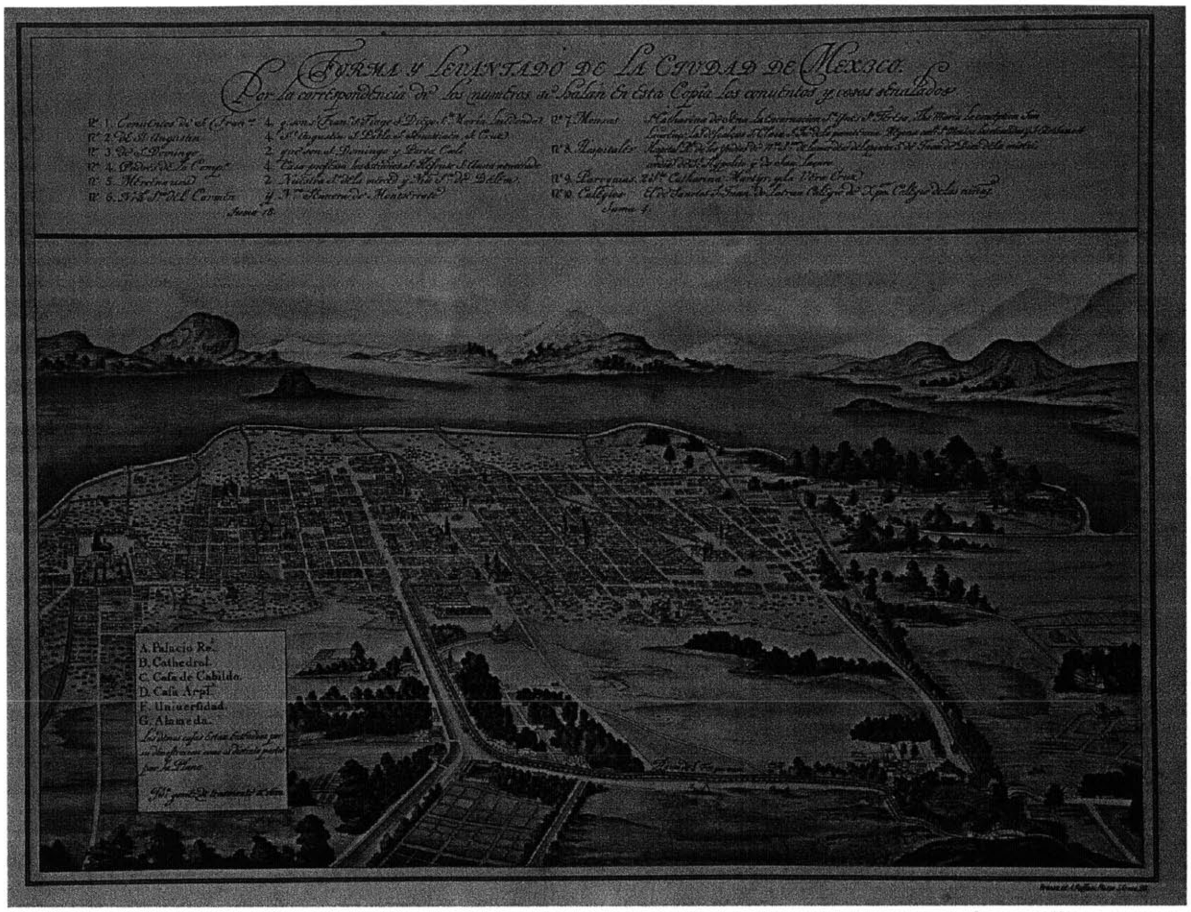

Fig. 1. Juan Gómez de Trasmonte (after), *Forma y levantado de la Ciudad de México*, c. 1628. Chromolithograph, 16 9/16 in. x 21 11/16 in. (42 x 55 cm). Source: Instituto de Investigaciones Estéticas, Mexico City. Studio of A. Ruffoni, Florence (1907), after Johannes Vingboons. Photograph provided by the Colección de acervo del Instituto de Investigaciones Estéticas, Universidad Nacional Autónoma de México.

Perhaps unsurprisingly, Mexico City was once again in the midst of floodwaters in 1629. The devastation and length of this inundation brought about significant changes to how colonial authorities tackled the problem of flood control. While in the Low Countries we can trace the existence of agencies devoted solely to the practice of water management (such as the polder boards) from the Middle Ages onward, we simply do not find an analogous example in the viceregal capital prior to the flood of 1629. From catastrophic inundation, we have the birth of the Office of the *Desagüe* in 1631. The sole mission of this agency was to end flooding, not only by overseeing drainage, but perhaps even more importantly, by bringing under the jurisdiction of

Fig. 2. Juan Gómez de Trasmonte (after), *Planta y Sitio de la Ciudad de México*, c.1628. Source: Bibliothèque nationale de France. Rating Plate: RC-A-90517, Prints and Photograph Department, Document Symbol: VD-31 (2)-FT4, Collection: Gaignières 6472, Folio: P 183736.

a single government office all matters related to flood control. Not unlike the implementation of a universal tax, with the Office we can also begin to see how water management required a more specialized form of governmental intervention.

Yet this new form of government was not independent of its colonial context. As we shall see, who would lead the Office was based on who controlled Indian tributary labor. The selection of the Franciscan Order in 1637 as superintendents of the Office was based, in part, on their proselytizing mission begun with the arrival of the Twelve Apostles in present-day Mexico in 1524, giving them administrative control over a large percentage of indigenous tribute workers in the early seventeenth century. The Order's tenure extended through 1691 without interruption (except for a single very brief period) that brought stability to water management. Prior to the

Order's selection, infighting between the different factions of government and prominent citizens was detrimental to achieving consensus when it came to implementing any flood control plan.[1] Scholars have referred to this period of Franciscan supervision as "The Golden Age of the *Desagüe.*" Above and beyond the creation of a new government agency, the Order was tasked to save the city by transforming Martínez' *desagüe* tunnel into a canal.

The conversion of the tunnel was a major engineering challenge. At its deepest point, it sat 149 feet below the surface of the earth. The reason for the conversion was simple: it was believed that it would prevent cave-ins, which blocked the flow of water, a common occurrence since nearly all of the tunnel was unreinforced. The Carmelite friar Andrés de San Miguel attempted to solve this engineering problem by employing Euclidian geometry. For the first time in the city's history, we find cross-sectional drawings and geometrical forms in the service of water management. These drawings represent a new effort, illustrating the canal and tunnel geometrically, to arrive at a flood control solution through mathematical deduction. Although the conversion and potential solution was a plan developed by San Miguel, he was passed over to lead the Office because the Carmelite friars lacked *doctrinas*, an ecclesiastical structure on which tributary labor was founded between the indigenous population and the Orders.

A comparison of Gómez de Trasmonte's *Forma y levantado de la Ciudad de México* and the anonymously authored *Ciudad de México anegada* (ca. 1629) provides us with an opportunity to understand the effects of the 1629-34 flood on the city's urban form. If the former identifies a utopian vision of the city on the one hand, then the latter shows how a disaster disfigured the city by stripping it of its spatial order. *Ciudad de México anegada* will also allow

[1] Hoberman, "Bureaucracy and Disaster."

us to examine the effects of flooding on ecclesiastical credit, in the form of a *censo* (Spanish for mortgage).

Lastly, we examine *La mui noble y leal Ciudad de México* of ca. 1690, an anonymous painting on a *biombo* (Japanese folding screen) in the collection of the Museo Franz Mayer in Mexico City. With Franciscan supervision over the Office of the *Desagüe* in mind, we will compare the *biombo's verso* image presenting the capital ca. 1690 with *Forma y levantado de la Ciudad de México* to identify how the former illustrates the capital as a secure mainland city. Art historian Michael Schreffler has claimed that the late seventeenth-century city presented in the *biombo* painting demonstrates the city's allegiance to the Spanish Crown.[2] Building upon Schreffler's argument, I outline the similarities between *Forma y levantado* and the *biombo* painting, but later identify a key difference between them. As we will see, *La mui noble y leal Ciudad de México* portrays environmental change in which the *desagüe* had overcome the challenges posed by Mexico City's natural setting and its historical path of development.

The Provenance of Juan Gómez de Trasmonte's Maps

Juan Gómez de Trasmonte's bird's-eye view and plan of Mexico City have a provenance that requires some explanation. The bird's-eye map located today in the Instituto de Investigaciones Estéticas at the Universidad Nacional Autónoma de México is not the original made by the Spaniard. It is a chromolithograph made by A. Ruffoni in 1907 in his Florentine studio at the request of the Mexican historian Francisco del Paso y Troncoso. In 1892, Paso y Troncoso was appointed director of Mexico's National Archaeological Museum (today, Museo Nacional de Antropología). Soon after he left for Europe. His quest: to locate Mexican primary

[2] Michael Schreffler, *The Art of Allegiance: Visual Culture and Imperial Power in Baroque New Spain* (University Park: Pennsylvania State University Press, 2007), 25.

source materials in European libraries, archives, and collections. His was an undertaking of considerable importance for gaining a greater understanding of Mexico's past. Paso y Troncoso spent the next twenty-four years in Europe, until his death in 1916 in Florence, Italy. Of the many discoveries by the Mexican historian was a set of four watercolors in a private collection in Belgium.[3] These consisted of the aforementioned bird's-eye view and plan and two views of the port cities of Acapulco and Vera Cruz by Adrian Boot: *Puerto de Acapulco en el Reino de la Nueva España en el Mar del Sur* and *Puerto de la Vera Cruz con la Fuerça de San Juan de Ulua en el Reino de la Nueva España en el Mar del Norte* (Figs. 3 & 4).

Adding another twist to the provenance of these images, the set of maps that Paso y Troncoso located were not the originals, either. Rather, these were mid-seventeenth-century watercolor copies made by the Amsterdam cartographer Johannes Vingboons. Fortunately, for scholars of the views, Vingboons attributed the originals to Gómez de Trasmonte and Boot, respectively.[4] Priscilla Connolly and Roberto L. Mayer have done an excellent job tracing Vingboons' copies in European, Latin American, and American collections. With respect to their work, perhaps two details deserve mention. They argued in "Vingboons, Trasmonte and Boot: European Cartography of Mexican Cities in the Early Seventeenth Century," that Vingboons' four watercolors were based on an equal number of oil-on-canvas paintings made by David Vinckboons, Vingboons' father.[5] In addition, they offer evidence that Vinckboons' paintings survived into the twentieth century, but were destroyed when Nazi Germany attacked the city of

[3] Toussaint, Gómez, de Orozco, and Fernández, *Planos de la Ciudad de México,* 191.

[4] Vingboons came from a family centered on the arts. His father, David, was a painter and engraver. His brothers, David, Philip, and Justus were mapmakers. The latter two were also architects. For a period of thirty years, Vingboons worked for the Dutch East India and West India companies, making charts, maps, and coastal views. See Michael Jarvis and Jeroen van Driel, "The Vingboons Chart of the James River, Virginia, circa 1617," *William and Mary Quarterly* 54, no. 2 (Apr., 1997), 378-379.

[5] Connolly and Mayer, "Vingboons, Trasmonte and Boot," 54.

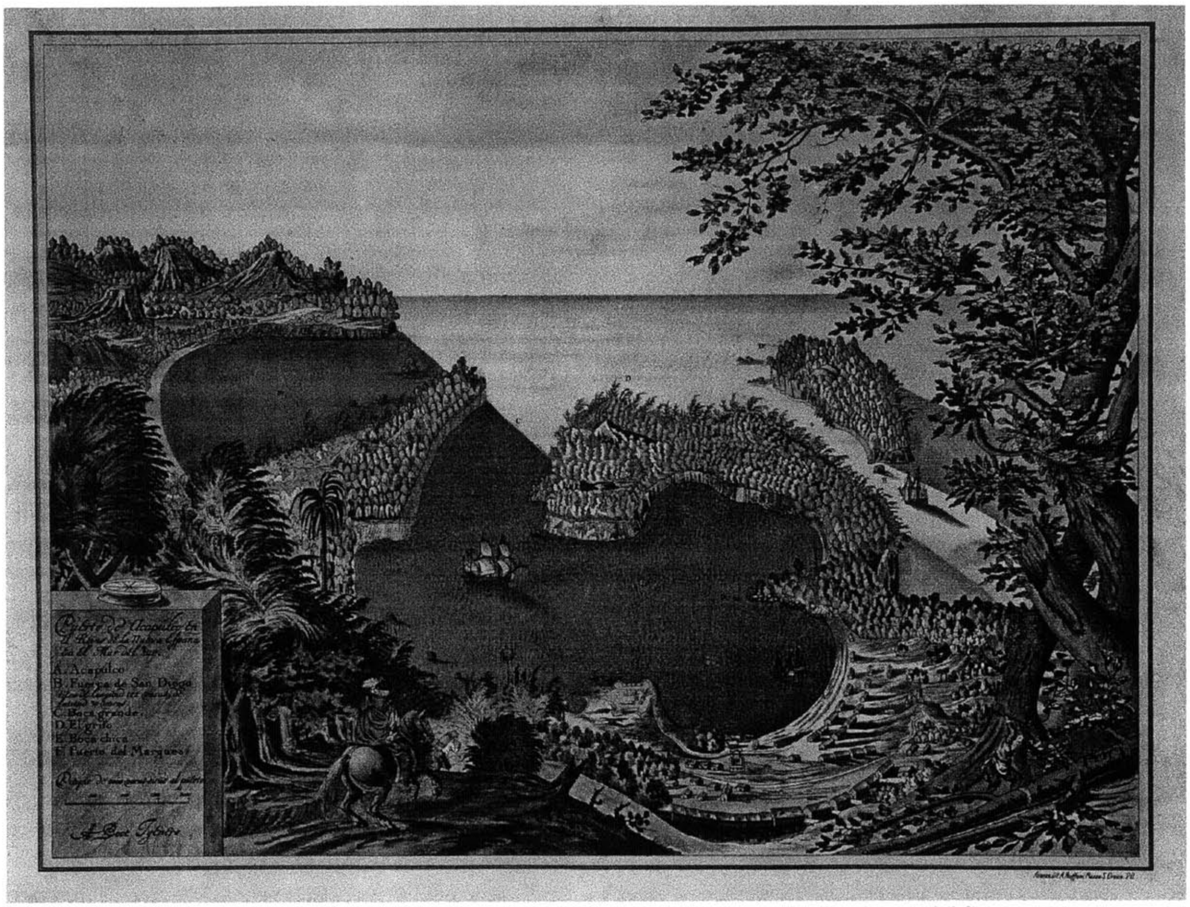

Fig. 3. Adrian Boot (after), *Puerto de Acapulco en el Reino de la Nueva España en el Mar del Sur*, c. 1628. Chromolithograph, 16 9/16 in. x 21 11/16 in. (42 x 55 cm). Instituto de Investigaciones Estéticas, Mexico City. Studio of A. Ruffoni, Florence (1907), after Johannes Vingboons. Photograph provided by the Colección de acervo del Instituto de Investigaciones Estéticas, Universidad Nacional Autónoma de México.

Middelburg in the Netherlands in 1940.[6] To date, the location of Gómez de Trasmonte's and Boot's originals is not known, if they even still exist.

When Paso y Troncoso came across the Vingboons' watercolors, he commissioned reproductions of only three of the four. Missing from the set is Mexico City's plan. Why it was not included is perplexing. Perhaps Paso y Troncoso found the views more valuable for an understanding of Mexico's history than a plan. The three chromolithographs were sent to the

6 *Ibid.*

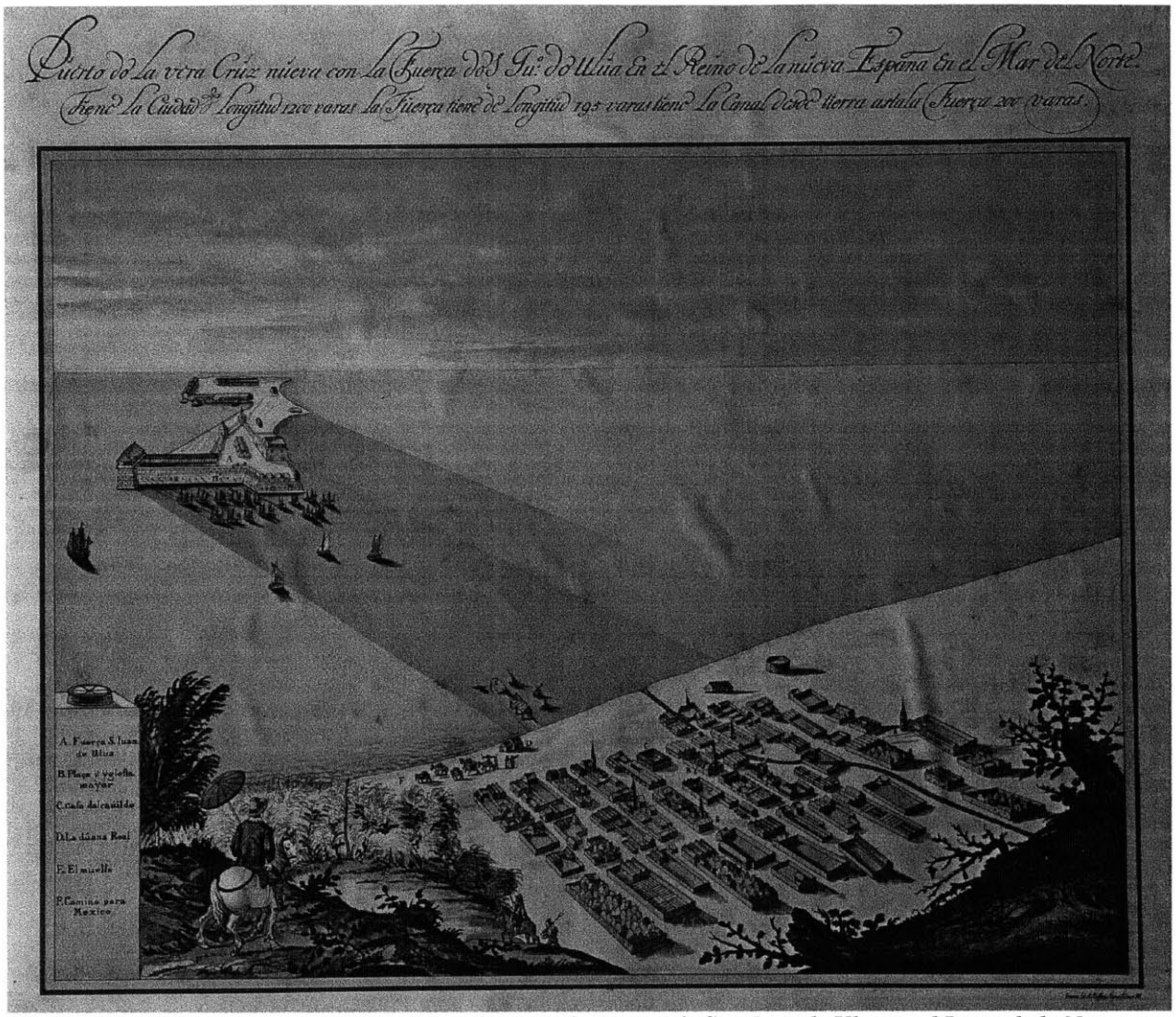

Fig. 4. Adrian Boot (after), *Puerto de la Vera Cruz con la Fuerça de San Juan de Ulua en el Reino de la Nueva España en el Mar del Norte*, c. 1628. Chromolithograph, 16 9/16 in. x 21 11/16 in. (42 x 55 cm). Instituto de Investigaciones Estéticas, Mexico City. Studio of A. Ruffoni, Florence (1907), after Johannes Vingboons. Photograph provided by the Colección de acervo del Instituto de Investigaciones Estéticas, Universidad Nacional Autónoma de México.

National Archaeological Museum in Mexico City, but for some unknown reason were put up for sale in 1921.[7] They were purchased by the Instituto de Investigaciones Estéticas, where we find them today.[8]

[7] Toussaint, Gómez, de Orozco, and Fernández, *Planos de la Ciudad de México,* 192.

[8] Boot's drawings merit attention in their own right. Their portrayal of early seventeenth-century military architecture in New Spain deserves study that is long overdue.

Water Management, Cartography, and Taxation

Between 1624 and 1647, the viceregal authorities frequently turned to Gómez de Trasmonte for his professional services. Trasmonte held the highly regarded title of *maestro mayor*. He supervised the design and construction of Mexico City's cathedral and worked on the cathedral at Puebla, as well as other religious and civic structures.[9] As part of his many hydraulic duties, he inspected the trench and tunnel of the *desagüe*, the city's causeways, canals, floodgates, and the dike of San Lázaro and supervised any repairs they required.[10] Trasmonte was also part of a group of experts on flood control that included Martínez, Boot, and Arias, among several others, who offered their professional advice on water management to the colonial authorities.[11] Gómez de Trasmonte's hydraulic responsibilities included studying the flood control proposal offered by Simón Méndez.[12] In a different case, he was requested to verify the existence of three large openings in the mountains, believed to be a means by which the *desagüe* could take place.[13] And in yet a third example, on March 15, 1630, he was asked to accompany Juan de Cevicos to the *desagüe* to verify the contents of a report written by Juan de Villabona.[14]

In 1628, Gómez de Trasmonte produced the previously mentioned bird's-eye view and plan of Mexico City. Why these drawings were made has been debated. On the one hand, Kagan has argued that the map-view and plan were administrative documents, prepared as part of a larger study of Boot's flood control proposal.[15] Kagan writes that:

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[9] For a general understanding of Juan Gómez de Trasmonte's professional activities see, "Juan Gómez de Trasmonte" in Fernández, *Arquitectura y gobierno virreinal*, 77-90.

[10] It is noteworthy that although the *desagüe* was the method preferred by the Spanish for combating inundations, the Aztec model was still in use at this time.

[11] A. C., June 26, 1627; Richard Everett Boyer, "La Ciudad de México en 1628: la visión de Juan Gómez de Trasmonte," *Historia Mexicana* 29, no. 3 (enero-marzo 1980), 452-453.

[12] Cepeda, Carrillo, and Serrano, *Relación universal*, 216.

[13] *Ibid.*, 219.

[14] *Ibid.*, 273-274.

[15] Kagan, *Urban Images of the Hispanic World*, 152-153.

> Acting either on the orders of Boot or the *cabildo* itself, Gómez de Trasmonte, a member of the municipal *desagüe* team, prepared a view of the city in order to show what it might look like once all of Boot's projected waterworks were in place.[16]

As we can conclude based on the research presented in Chapter 4, Kagan's claim would be difficult to prove. Boot's proposal included building a dike on the western side of the city, which would enclose the settlement by connecting with the existing dike of San Lázaro located on the island's eastern side. If Kagan's hypothesis were correct, we would find Mexico City enclosed within a circular dike, lined by boat ramps and wind-aided machines. Yet these hydraulic structures are nowhere to be found in either the bird's-eye view or plan.[17] Thus it is inconceivable that these drawings were made with Boot's proposal in mind.

Mayer has also argued that the Spanish architect's drawings were administrative documents. But in contrast to Kagan, in "Trasmonte y Boot: sus vistas de tres ciudades mexicanas en el siglo XVII," Mayer maintained that these drawings were made to aid the municipal government in levying a tax on the city's buildings, whose revenue would be used to pay for the *desagüe*.[18] The making of a map to raise funds for flood control purposes is not without precedent.[19] In 1607, the architect Andrés de la Concha made a map of the capital

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[16] *Ibid.*, 153.

[17] Additional evidence suggests Gómez de Trasmonte's drawings were not made with Boot in mind. After Martínez' *desagüe* had been constructed it fell into disfavor. Other drainage proponents condemned the project, calling it a waste of money and ineffective. Their hope was to find favor for their own drainage schemes with the viceregal authorities. In the middle of this infighting, Gómez de Trasmonte came to the aid of Martínez. The Spanish architect disapproved of the other drainage schemes, calling them "impossible," and continued by stating that the only method for saving Mexico City was to "conserve" Martínez' desagüe. Consult Cepeda, Carrillo, and Serrano, *Relación universal*, 335.

[18] Mayer, "Trasmonte y Boot," 185.

[19] *Ibid.*, 185-86. See also Roberto L. Mayer, *Poblaciones Mexicanas, planos y panoramas, siglos XVI al XIX = Mexican Towns, Plans and Panoramas, 16th to 19th Centuries* (Mexico City: Smurfit Cartón y Papel de México, 1998), 105.

depicting its structures, including churches, convents, monasteries, and hospitals.[20] The drawing was used to assess a tariff on building owners.[21] Taxation to support drainage was not a new idea. For example, in 1571, the *sisa*, or sales tax, on wine was imposed to pay for all public works projects, including flood control.[22] At only one-eighth a *real*, the tariff was insufficient to fund all the city projects, which also included public celebrations.[23] Given this shortfall, with the floods in 1604 and 1607, the city treasury tried to offset the cost of repairs to the causeways with an infusion of funds.[24] Yet the treasury's efforts were not enough to meet the cost of repairs necessitated by the floods. As a result of this financial gap, Viceroy Velasco turned to a different source of income: unclaimed inheritances. In November 1607, he redirected 15,000 *pesos* from this fund towards flood-related repairs.[25] Still, this cumulative effort fell short. Perhaps as a last resort to underwrite the repairs required, Velasco turned to the taxation of public and private property.

Hoberman has pointed out that until this point, the responsibility of property owners to the city functioned differently.[26] For example, property owners were only liable for the maintenance of the portion of a street or canal adjacent to their property. It is a framework of individualized responsibility, where a person was only financially responsible for the maintenance or improvement to public property nearest their home, and by extension, their neighbor down the street was not. Thus what makes Velasco's 1607 tax significant is its

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[20] Mayer, "Trasmonte y Boot," 185; Frederik Caspar Wieder, *Monumenta Cartographica: Reproductions of Unique and Rare Maps, Plans, and Views in the actual size of the originals* (The Hague: M. Nijhoff, 1925-1933), 1:110; *Memoria, histórica, técnica, y administrativa*, vol. 1, 99; Mathes, "To Save a City," 432.
[21] Hoberman, "City Planning in Spanish Colonial Government," 82; Richard Everett Boyer, "Mexico City and the Great Flood: Aspects of Life and Society, 1629-1635" (Ph.D. diss., University of Connecticut, 1973), 119.
[22] Hoberman, "City Planning in Spanish Colonial Government," 80.
[23] *Ibid.*
[24] *Ibid.*
[25] *Ibid.*, 81.
[26] *Ibid.*, 82.

universal application, where monies collected would be applied towards the benefit of all the residents of Mexico City.[27] It is an idea underscored when Velasco responded to the complaints of many with the following words: "[T]he money must come from those who are interested in the *desagüe* and it is obvious how interested all members of this Republic must be, both laymen and ecclesiastics. . . ."[28]

A property tax was a new method for raising funds. As a result, it required a new method for assessing the levy. In order to do so, Velasco commissioned Concha to produce his 1607 map of the city, showing its "convents, religious brotherhoods, hospitals, schools, and municipal and royal government offices."[29] With the idea of taxation and mapmaking in mind, Mayer's hypothesis that Gómez de Trasmonte's drawings were also made to raise funds for the *desagüe* is reasonable. Further archival research is required if Mayer's view is to be proven correct.[30] Regardless of the intended use of Gómez de Trasmonte's drawings, the bird's-eye view and plan fulfill a most important function: they offer a visual description of the city and its relationship to the lakes.

Two New Views of Mexico City

Forma y levantado de la Ciudad de México and *Planta y sitio de la Ciudad de México* present us with an entirely new manner for conceptualizing the city. Until this point, no bird's-eye view or ichnographic plan had been made of the viceregal capital. Only more than a century after Jacopo de' Barbari's bird's-eye *View of Venice* (of 1500) and Leonard da Vinci's

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[27] In practice, the tax was not applied uniformly. As already noted in Chapter 3, private owners were taxed at 1.5%, but ecclesiastical property was taxed at the lower rate of .75%.
[28] As quoted in Hoberman, "City Planning in Spanish Colonial Government," 83.
[29] Cepeda, Carrillo, and Serrano, *Relación universal*, 68. Hoberman, "City Planning in Spanish Colonial Government," 82; and Boyer, "Mexico City and the Great Flood," 119.
[30] A comparative study of Concha's map and those of Gómez de Trasmonte's might aid in understanding if the latter was produced for taxation purposes. Unfortunately, the location of Concha's map is unknown.

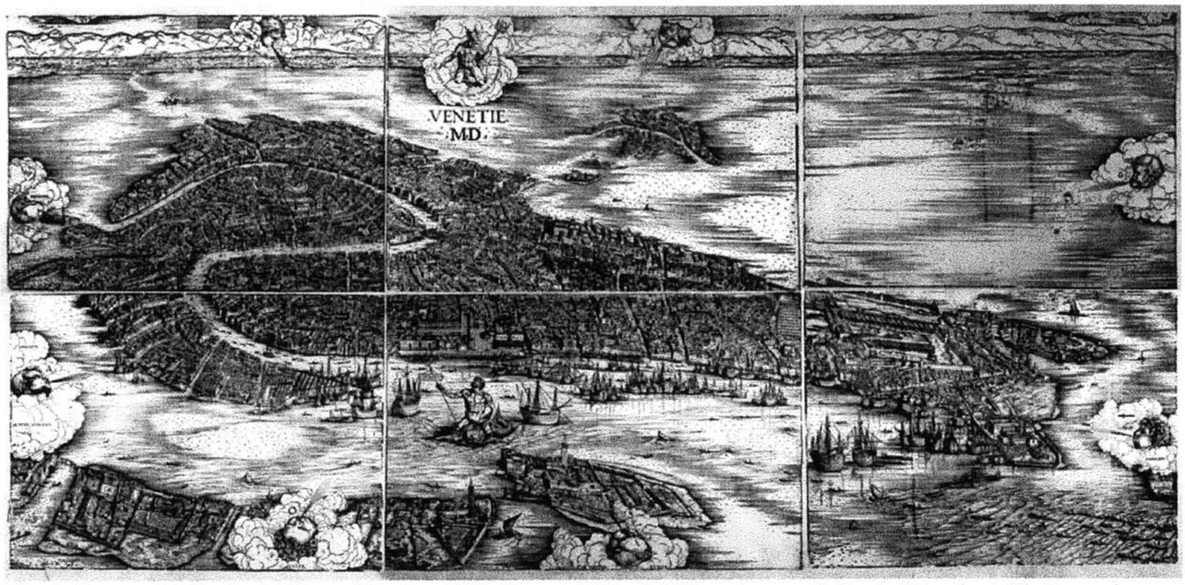

Fig. 5. Jacopo de' Barberi, *View of Venice*, 1500. Size: 1.345 x 2.818 meters on 6 sheets; Woodcut. Photograph courtesy of The Newberry Library, Chicago. Collection No. Novacco 8F7.

Fig. 6. Leonardo da Vinci, *Plan of Imola*, 1502.
https://upload.wikimedia.org/wikipedia/commons/d/d1/Leonardo_da_vinci%2C_Town_plan_of_Imola.jpg
Accessed: June 8, 2013.

ichnographic drawing, *Plan of Imola* (of 1502), do we find the first portrayal of Mexico City using these methods of cartographic projection (Figs. 5 & 6).[31] These drawings anticipate Gómez de Trasmonte's understanding of European cartography. Important for understanding Gómez de Trasmonte's cartographic intentions are that the drawings are a set. An examination of Mexico City maps has shown that no other indigenous or European mapmaker ever produced two correlating images of the city. Both drawings were made *in situ*, based on empirical observation.

Both images offer a visual perspective of Mexico City. Each identifies the capital as the focal point of observation. The two depict the settlement's archetypal image: a city surrounded by water. And lastly, each portrays the capital's orderly plan. In spite of these cartographic similarities, why did Gómez de Trasmonte make two drawings of Mexico City? Would not one or the other suffice to convey his visual intentions? In his hypothesis of *cartographic silence*, Harley demonstrated how cartographers undertake a process of selecting and synthesizing data when making a map.[32] That is, mapmakers do not attempt to illustrate every topographic detail. As a result, no cartographic image can offer an all-encompassing picture. The coupling of these images serves to provide a more inclusive perspective on the settlement and, given their respective methods of projection, each is attuned to a specific message.

Planta y sitio de la Ciudad de México is an ink and watercolor drawing.[33] A scale bar measuring one thousand *varas* is located in the lower right-hand corner of the map. Immediately above it, we find the name of Juan Gómez de Trasmonte. (North is to the left-hand side of the map.) In a cartouche across the top of the map, the following Spanish inscription reads:

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[31] For an understanding of the *View of Venice*, see Juergen Schulz, "Jacopo de' Barbari's View of Venice: Map Making, City Views, and Moralized Geography before the Year 1500," *Art Bulletin* 60, no. 3 (Sep., 1978): 425-474.

[32] Harley, *The New Nature of Maps*, 85.

[33] My study of Gómez de Trasmonte's plan is based on the copy owned by the Bibliothèque nationale de France.

> A esta ciudad la rodea el agua por toda partes como parece, y corren todas las aguas a la laguna grande de San Lázaro que tiene de circuito 14 leguas castellanas sin otras lagunas que hay donde se divide el agua que esto toca a descripción General y asi no se trata mas de lo que hace a este proposito, Tiene esta ciudad hasta 10,000 vecinos, y de arrabales que son casas de indios hasta nueve mil y estas la mayor parte están hoy anegadas, como todo se significa nuestro Planta que esta sacada con puntualidad y cuidado año 1628. La longitud y espacio de las cuadras de casas que se significan por los cuadrangulos naranjados se hallarán por el pitipie, que solo para esto, y para los sitios de los conventos y los más que van señalados sirve, por que las calles unas tienen 14 a 15 y a 16 varas de ancho, y asi por esto y por hacer mejor distinción no van respectivo con el pitipie que no las cuadras y sitios dichos.
>
> [This city is surrounded by water as shown. All the waters run into the large lake of San Lázaro, which alone has a circumference of 14 Castilian leagues, not counting the other lakes which are not shown in this general description. The city has up to 10,000 neighbors, and the barrios where Indians live have up to nine thousand houses, most of which are flooded today. All that is indicated on this map was done on time and with care in 1628. The length and width of the city blocks, which are shown as orange quadrangles, are in scale; the sites of the convents, and the others indicated are also in scale, but because streets are 14, 15, or 16 varas wide to make them more distinct, they are not in scale with the city blocks and sites mentioned.][34]

In the upper left-hand corner of the map, a second cartouche can be located. In it, Gómez de Trasmonte provided the title of the map and a description of the city's religious corporations and the buildings they own. Mexico City encompassed at least twenty monasteries and sixteen convents.[35] The city is presented as two parts. The Spanish portion of the island is shown as a series of orange quadrangles, which are drawn to scale, according to the inscription. Surrounding this orderly urban plan are the Indian barrios, which are amorphously organized. In the plan, the difference in the spatial organization of these two zones is noticeable, but in the bird's-eye view, the contrast between the low-lying Indian adobe homes and the "monumentality" of Spanish civic and private buildings is more palpable.[36]

The Spanish portion of the city now appears to have achieved spatial regularity. In the settlement's infancy, the reader may recall, that the *cabildo* strove to implement orderly urban form. Now, the questions posed in Chapter 2 (when examining the *Uppsala Map*) about the

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[34] The transcription and translation are mine. Sonia Lombardo de Ruiz offered a slightly different transcription and hence translation based on her reading of the plan in the Biblioteca Medicea Laurenziana's collection. See Lombardo de Ruiz *Atlas histórico de la Ciudad de México* (Mexico City: Smurfit Cartón y Papel de México, 1996), 2:446-447.

[35] José María Marroqui, *La Ciudad de México* (Mexico City: Tip. Y Lit. "La Europea," de J. Aguilar y Ca., 1900), 1:71; Boyer, "Mexico City and the Great Flood," 62.

[36] Gibson, *The Aztecs Under Spanish Rule*, 370.

city's spatial regularity, and thus its *policía,* appear resolved. Equally as significant, the comparison between these maps also allows us to reconsider the urban and aquatic character of the island in the 1620s. Recall that in the *Uppsala Map*, Mexico City was separated from Tlatelolco, its sister city to the north, by the *lagunilla* and the Tezontlalli canal. Notice that in the Spaniard's plan, the *lagunilla* has disappeared.[37] The canal, now spanned by bridges, adheres to the regularity of the city. In turn, Mexico City and Tlatelolco are shown united, whereas before they were correctly depicted as two separate locales on the island.[38] Also recall that the *cabildo*, as early as November 1535, had already planned for the day when Mexico City and Tlatelolco would be connected, when decreeing that no building be built in the path of the yet-to-be-constructed streets that would link the two.[39] Gómez de Trasmonte's graphic commentary highlights the way the city's hydrology has been reshaped in relation to the colonial built environment. The resulting transformation can be conceived as a function of Spanish (and now also Creole—Spaniards born in the New World) intent to not only meet the demands of urban growth, but to change the urban character of the island from an Indian form to an ideal European one.[40]

Leonardo da Vinci's *Plan of Imola* aids understanding of *Planta y sitio de la Ciudad de México.* In 1502, da Vinci became the architect and engineer to the Duke of Valentinois, Cesare Borgia, and soon after produced his famous plan of this Italian town.[41] The significant characteristic of this drawing is that buildings, streets, and squares, among many other architectural features, are shown from an "infinite number of viewpoints, all perpendicular to

[37] Toussaint, Gómez de Orozco, and Fernández, *Planos de la Ciudad de México*, 187.
[38] *Ibid.*, 183.
[39] A. C., November 27, 1535.
[40] Not in all instances was the city's relationship to water depicted differently. Notice how the dike of San Lázaro still protects the island's eastern shoreline from any potential floodwaters.
[41] John Pinto, "Origins and Development of the Ichnographic City Plan," *Journal of the Society of Architectural Historians* 35, no. 1 (Mar., 1976), 38.

each topographical feature."[42] Unlike where spatial depth is privileged in perspective, all vertical depth in this method is compressed into a singular horizontal plane. The resulting effect is one of "flatness."[43] In Gómez de Trasmonte's plan, the city is also depicted from a highly unrealistic vantage point: perpendicular to each architectural element, where the distortion of parallax has also been eliminated.[44] Like Imola, Mexico City is portrayed as a series of voids and solids, respectively representing open spaces and built elements. Undergirding this method of cartographic projection is mathematical abstraction, demanding a "high degree of skill to measure and record" the city's constituting parts to present them in correct proportion.[45] In "Origins and Development of the Ichnographic City Plan," John Pinto outlined the importance of surveying to the making of the *Plan of Imola*. By extrapolating from Pinto's scholarship, we can thus imagine the Spanish architect walking Mexico City, measuring city block after city block, street after street, to determine their spatial relationship geometrically. Indeed, an ichnographic plan requires surveying.[46]

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[42] *Ibid.*, 35. See also Hilary Ballon and David Friedman, "Portraying the City in Early Modern Europe: Measurement, Representation, and Planning," in *The History of Cartography* (Chicago: University of Chicago, 2007), 3:689.
[43] Pinto, "Origins and Development of the Ichnographic City Plan," 35; Ballon and Friedman, "Portraying the City in Early Modern Europe," 689.
[44] Pinto, "Origins and Development of the Ichnographic City Plan," 35 and 40.
[45] *Ibid.*, 35.
[46] The mathematical abstraction employed by Gómez de Trasmonte is unlike that used by Enrico Martínez in *Descripción de la comarca de México i obra del desagüe de la laguna*. Although mathematical abstraction in the service of cartography is one of the great contributions of the Renaissance, Martínez and Gómez de Trasmonte employed it quite differently. Whereas the former used a scale bar and dividing compass to chart the path of the *desagüe*, the latter employed scale to chart the city. The differences in their respective approaches offer us two fundamentally different pictures of the city. For Martínez, the city stood as cartographic symbol standing in place of the island settlement, while Gómez de Trasmonte presented the spatial character as documentary evidence. Gómez de Trasmonte's drawing is not wholly an ichnographic plan. However, the inclusion of topographical relief to illustrate land, lake, and flora in the lower section of the map, or western side of the city, is not problematic. Many ichnographic drawings of this period included some topographical relief.

The purpose of an ichnographic drawing is to demonstrate the "global form of the city."[47] It does not purport to describe the city in three-dimensional space, and thus does not intend to "stimulate optical experience."[48] Gómez de Trasmonte's training in mapmaking more than likely made him aware of the limitations of the ichnographic plan, and perhaps as a means of providing a more inclusive perspective on the character of Mexico City, he also made the bird's-eye view.

Forma y levantado de la ciudad de México portrays Mexico City from a bird's vantage point, as if flying west of the city and looking in an easterly direction.[49] It provides direct sightlines to the most important buildings of the city, which the architect identified with a legend in the lower left-hand corner of the view. Trasmonte presents the Spanish city as an ordered settlement. City blocks and streets adhere to an orthogonal plan. On the city's eastern side, the dike of San Lázaro follows the contours of the island's shoreline. Noticeably absent in the bird's-eye view is the pre-Columbian dike of Nezahualcóyotl. By offering a picture of the capital's buildings, plazas, streets, outlying Indian barrios, and hydraulic structure, the map-view illustrates the architectural fabric of the city. Unlike his plan, Gómez de Trasmonte's use of perspective allowed for illustrating the vertical scale of the city. Important buildings, outlined in the legend, tower over the nondescript low-lying structures surrounding them with their blue roofs. Equally important, the presence of perspective, albeit from several different viewing points, marks a definitive break from any anterior description of the city. As a result, Gómez de Trasmonte provides the viewer with an elevated and distant vantage point that allows for a wide

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[47] Ballon and Friedman, "Portraying the City in Early Modern Europe," 689.
[48] *Ibid.*
[49] Toussaint, Gómez de Orozco, and Fernández, *Planos de la Ciudad de México,* 175; Boyer, "La Ciudad de México en 1628," 448.

visual field and thus the opportunity to scan, interpret, and synthesize the city in a single glance.[50]

Forma y levantado de la Ciudad de México presents a tranquil image of Mexico City. The rising sun crests over the eastern horizon as the day is set to begin. Volcanoes and mountains tower thousands of feet above the basin's floor, but do not overwhelm the city. In fact, Mexico City, its outlying districts, and its hydrographic elements, which are quietly nestled among groves of trees within the blue waters of Lake Mexico, command the viewer's attention. However, the idyllic portrayal of Mexico City in its natural setting is deceptive. The stillness of the lake's waters, with their varying hues of blue, conceals the risks of flooding. Mesmerized by the seductive image of the capital, one easily forgets about the dangers of a deluge. In reality, on any given day during the rainy season, the city was at the mercy of its natural setting. Instead of capturing how the city was susceptible to flooding, Trasmonte quite skillfully offers a utopian vision of the city's relationship to nature. However appealing, it was a perspective that would come to an end only a year later.

Nature's Wrath: The Flood of 1629-34

Mexico City was again inundated in 1629. On June 20, the waters of the Cuautitlán River broke through the dike of Coyotepec.[51] By October 12, the low-lying areas of the city were a *vara* underwater, and by October 27, the floodwaters had reached the island's high ground to inundate the city's public square, the *Plaza Mayor*.[52] This deluge was no ordinary flood, if a flood can ever be considered ordinary. The rushing waters did not spare men, women, or

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[50] It is a feat not otherwise possible from the lower vantage points of the oblique, equestrian, and profile views.
[51] See Carlos Chanfón Olmos, ed., *Historia de la arquitectura y el urbanismo Mexicanos*, vol. 2, bk. 3 (Mexico City: Fondo de Cultura Económica, 1997), 338.
[52] *Ibid.*

children. Human loss was high. It is believed that 35 to 40 percent of the Indian population alone, some thirty thousand, perished.[53] Of those who were lucky enough to survive the initial onslaught, seventy-five percent fled the city, leaving the once densely populated island settlement nearly abandoned.[54] In the case of Mexico City's white population (Spaniards and Creoles), Gibson's table is a good index for understanding the mass exodus (Fig. 7). The table indicates that the white population consisted of twenty thousand families in 1629, but that by 1646, the island might have counted only eight thousand families. As overwhelming as these figures may sound, the magnitude of the flood was also felt when the floodwaters did not recede. Unlike previous inundations when water levels returned to normal after a few months, many parts of the city remained submerged through 1634.[55] In neither the pre-Columbian nor the colonial period had an inundation lasted as long! Perhaps no words can fully capture the extent of the disaster, but historian Richard Boyer reminds us of the dreadful impact of inundation:

> The havoc by this flood took nearly a generation to repair. The deaths, population exodus, property losses, and commercial paralysis was unprecedented.[56]

Indeed, the city was in shambles. The great capital of the Spanish New World had fallen under the wrath of an enemy that carried no sword or gun. The devastation provoked comparison to Troy, the fallen city of antiquity, when the Archbishop Francisco de Manso Zuñiga y Sola wrote to Philip IV on October 1, 1629 about the disaster.[57]

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[53] Boyer, "Mexico City and the Great Flood," 188.
[54] *Ibid.*
[55] For an understanding of the effects of the flood see Boyer, "Mexico City and the Great Flood," later published in Spanish as *La gran inundación: vida y sociedad en México, 1629-1638.*
[56] Boyer, "Mexico City and the Great Flood," 2.
[57] *Ibid.*, 32-33.

Date[a]	Number	Unit	Source
1525	150	houses	CDIAI, XIII, 77.
1550*	2,000	vecinos	López de Gómara, *Historia*, II, 106.
1557	1,500	households	Hakluyt, *The Principal Navigations*, IX, 355 (Robert Tomson).
1560*	3,000	houses	Latorre, *Relaciones geográficas*, p. 104.
1560*	8,000	men	Latorre, *Relaciones geográficas*, p. 104.
1569	5,000 to 6,000	men (?)	NCDHM (1941), II, 4.
1570	3,000	vecinos	López de Velasco, *Geografía y descripción*, p. 189.
1572	5,000 to 6,000	houses	Hakluyt, *The Principal Navigations*, IX, 380 (Henry Hawks).
1581*	4,000	vecinos	ENE, XV, 50.
1581*	8,000	men	ENE, XV, 50.
1585*	3,000+	vecinos	CDIHE, LVII, 174.
1600*	12,000 to 15,000	total (?)	Champlain, "Brief discovrs des choses," p. 41.
1610*	7,000	households (?)	Torquemada, *Monarchia indiana*, I, 299.
1612*	15,000+	total (?)	Vázquez de Espinosa, *Compendium and Description*, p. 156.
1625	30,000 to 40,000	total (?)	Gage, *A New Survey*, p. 122.
1629	20,000	families	*Memoria histórica . . . del desagüe* I, 132.
1646	8,000+	families (?)	Díez de la Calle, *Memorial*, p. 110.
1742*	50,000+	families	Villa-señor y Sánchez, *Theatro americano*, I, 35.
1790	52,706	total (except ecclesiastics and troops)[b]	"Noticias de Nueva-España en 1805," p. 8. Humboldt, *Political Essay*, I, 254.
1802*	67,500	total	Humboldt, *Political Essay*, II, 62.

Fig. 7. White Population Demographics, Mexico City.

No image better reveals the destructive forces of the flood than the anonymously authored *Ciudad de México anegada* ca. 1628 (Fig. 8).[58] At the center of the image, one finds a devastated Mexico City. At the perimeter of the capital, paddlers in canoes make their way over the submerged low-lying areas of the city. These areas underwater primarily represent the barrios.

[58] My study of *Ciudad de México anegada* is based on a published version of the original. According to Ola Apenes the original was in the collection of the *Archivo General de la Nación* in 1920, but has since disappeared. To the disappointment of this author, Apenes did not offer the image's archival reference information. According to Apenes, Jorge Enciso made the copy for publication in the Mexico City newspaper, the *Excelsior*. See Apenes, *Mapas antiguos del Valle de México*, 22. The image used in this dissertation was provided by the Mapoteca Orozco y Berra, located in Mexico City, which was taken from *Memoria de las obras del sistema de drenaje profundo del Distrito Federal*, tomo 11-7.

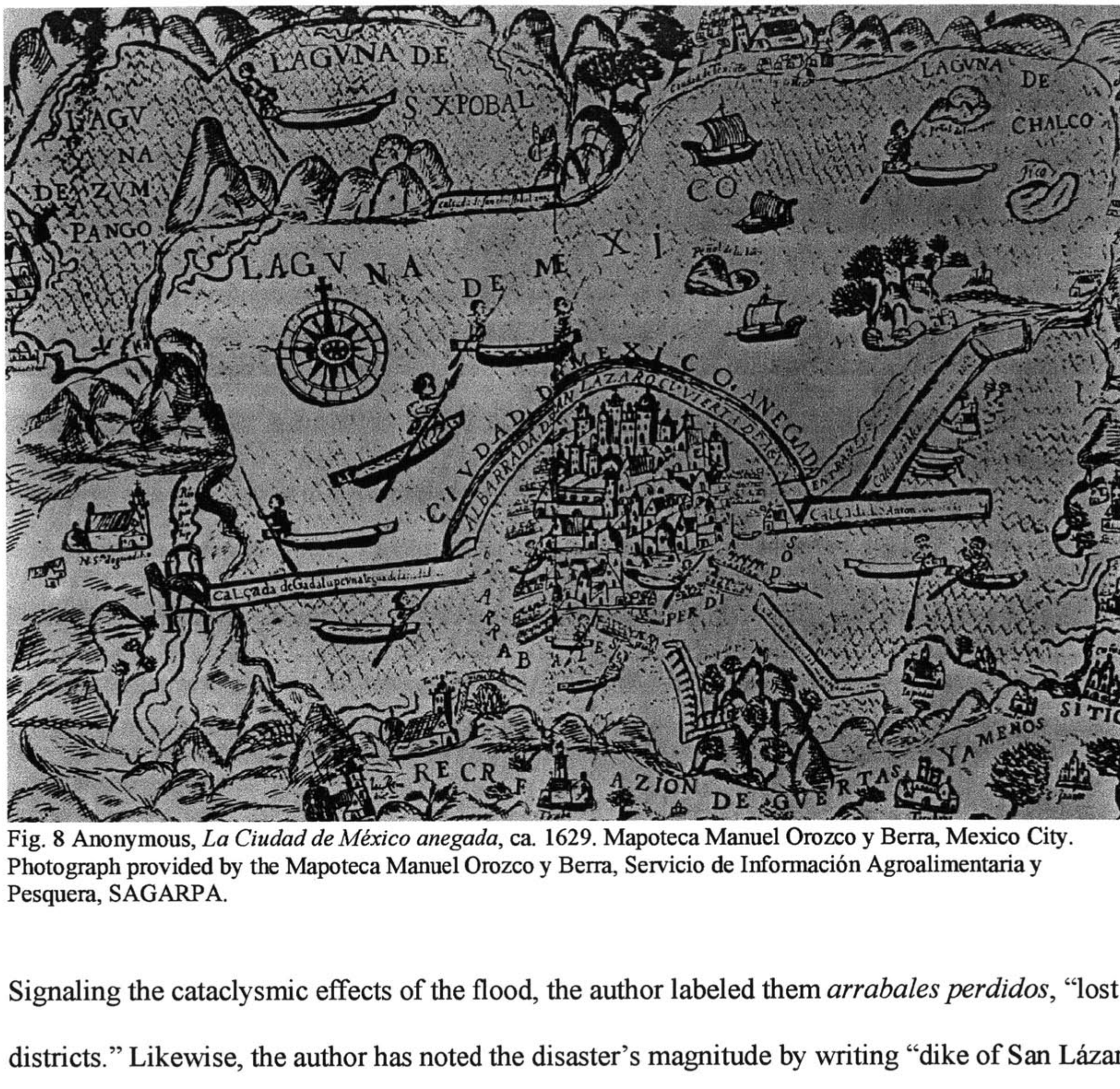

Fig. 8 Anonymous, *La Ciudad de México anegada*, ca. 1629. Mapoteca Manuel Orozco y Berra, Mexico City. Photograph provided by the Mapoteca Manuel Orozco y Berra, Servicio de Información Agroalimentaria y Pesquera, SAGARPA.

Signaling the cataclysmic effects of the flood, the author labeled them *arrabales perdidos*, "lost districts." Likewise, the author has noted the disaster's magnitude by writing "dike of San Lázaro covered by water" over this hydraulic structure. This dike, which gracefully meandered along the city's eastern shoreline in Trasmonte's *Forma y levantado de la Ciudad de México*, was the city's last line of defense against surging waters. With the dike completely overrun by water, the capital, lacking any protection, was now at the mercy of its natural setting.

The flood's fury is nowhere more evident than in the depiction of the city's spatial organization. The few colonial buildings that remain are shown as if they had scurried away from the surging waters, and by doing so, become chaotically arranged on higher ground. In marked contrast to Trasmonte's portrayal of Mexico City's orderly urban layout, where city block after city block was arranged in sequential uniformity, *Ciudad de México anegada* reveals the destructive nature of flooding, showing us how it disfigured the city by stripping it of any spatial order. If *Forma y levantado de la Ciudad de México* was an idyllic portrayal of the city within its natural environment, then *Ciudad de México anegada* is its opposite, a portrayal of nature's wrath unleashed upon the capital.

Flooding and Ecclesiastical Credit

Ciudad de México anegada offers an opportunity to analyze the flood's effect upon ecclesiastical credit. Boyer has noted that religious corporations regularly loaned money to the city's inhabitants in the form of a *censo* (mortgage) to purchase a home or to invest in commercial activities.[59] In return, religious corportations would receive interest in the amount of five percent annually on their investment, and in addition, a home or commercial property as collateral.[60] Under normal circumstances, lending was a lucrative venture for religious corporations with minimal risk. However, Mexico City's setting added considerable risk to the practice that was not accounted for in interest rates. Surprisingly, rates for the mainland and the island were identical!

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[59] Boyer, "Mexico City and the Great Flood," 35-37.

[60] Credit rates went down significantly over time. From the inception of the colonial period to 1563, the rate of interest was 10% per annum; from 1563 to 1608, it was 7.14%; and thereafter, it dropped to 5%. See María Pilar Martínez López-Cano, *La genesis de crédito colonial: Ciudad de México, siglo XVI* (Mexico City: Instituto de Investigaciones Estéticas, Universidad Nacional Autónoma de México, 2001), 206 and 212. The lowering of interest to 5% was by royal decree, initiated by Philip III on January 25, 1608. The change in rate took effect on January 29, 1609. See Jean-Pierre Berthe, "Contribución a la historia del crédito en la Nueva España (siglos XVI, XVII, XVII)," in *Prestar y pedir prestado: relaciones sociales y crédito en México del siglo XVI al XX*, ed. Marie-Nöelle Chamoux, Danièle Dehouve, Cécile Gouy-Gilbert, and Marielle Pepin Lehalleur (Mexico City: Centro de Investigaciones y Estudios Superiores en Antropología Social / Centro de Estudios Mexicanos y Centroamericanos, 1993), 28.

Flooding changed the equilibrium of how the *censo* functioned between borrower and lender. With many of the city's private, commercial, and public buildings destroyed or badly damaged, many borrowers that survived the flood simply walked away from them, and by extension, their debt obligation. In turn, the lien holders—religious corporations—became the unintentional owners of buildings in ruins. Religious entities were not in the business of owning property, as much as they were interested in owning the note that would bring them a steady return on their investment over a period of years. The flood thus put these corporations in an unwelcome position. Not wanting the responsibility of damaged property, they undertook several approaches to alleviate their newfound burden.

In March 1630, for example, the Hospital del Amor de Dios began inspecting the homes they now owned by default due to the flood.[61] Juan Gómez de Trasmonte and Franco de Pareja examined several, suggesting they be sold at auction.[62] On February 7, 1635, the Hospital sold "ten pair of houses."[63] In a different case, the Mercedarians held a lien on the home of Martínez de Quesada, for which he paid 100 *pesos* annually.[64] In the aftermath of the flood, like so many others, he abandoned his house, forcing the brotherhood to take possession of it. Unlike the approach taken by the Hospital of selling their damaged properties, the Mercedarians chose a different option. They rented the home to Cristobál Negrete, but not without taking a significant loss on their investment.[65] Negrete agreed to pay the Mercedarians the sum of only thirty-eight *pesos* a year. Other religious corporations were not as fortunate. The convent of Santa Clara lost

[61] Boyer, "Mexico City and the Great Flood," 38.
[62] *Ibid.*, 39-40.
[63] *Ibid.*, 40.
[64] *Ibid.*, 43.
[65] *Ibid.*

upwards of 56,000 *pesos* on loans secured by homes damaged by the inundation.[66] To put this figure in perspective, it was one-fifth of their total assets.[67] In another example, we find a yet different approach undertaken by the convent of Jesús María. They rented their damaged homes under the concept of *censo enfitéutico*, an accord that required the renter to improve the property with construction in exchange for rent.[68] Countless more examples can be provided about the relationship between ecclesiastical credit and flooding, but the point is clear: environmental disaster had a negative impact on seventeenth-century Mexico City's credit structure.[69]

The flood of 1629-34 made it abundantly clear that the *desagüe* had failed to protect Mexico City. It also brought to an end any ongoing debate between Martínez' *desagüe* and Boot's *protective circle* and started a different discussion about water management.[70]

A King's Mandate: Relocate to Higher Ground

In 1631, with the flood into its second year and no end in sight, royal intervention was not far off. On May 19, the Spanish monarch Philip IV decreed that Mexico City be relocated to the mainland.[71] Philip directed that a new capital city be founded between the towns of Tacuba and Tacubaya, a mainland location west of the island. Implicit in Philip's decree is a

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[66] Berthe, "Contribución a la historia del crédito en la Nueva España," 30.
[67] *Ibid.*
[68] María del Pilar Martínez López-Cano, *El crédito a largo plazo en el siglo XVI* (Mexico City: Instituto de Investigaciones Históricas, Universidad Nacional Autónoma de México, 1995), 175.
[69] In a different context, Linda Greenow tackled the topic of ecclesiastical credit in colonial Mexico. She claims that, although viceregal credit had its origins in Spain, the Church quickly developed its own capitalist structure to support the economic development of the viceroyalty. In short, she makes the claim that the Catholic Church's role in money-lending translated into urban and rural economic growth. Linda Greenow, *Credit and Socioeconomic Change in Colonial Mexico: Loans and Mortgages in Guadalajara, 1720-1820* (Boulder: Westview Press, 1983), 11. In particular, see the section entitled "The Theoretical Context: The Significance of Credit," 7-13.
[70] Hoberman, "Technological Change in a Traditional Society," 170.
[71] Hoberman, "City Planning in Spanish Colonial Government," 220; Boyer, "Mexico City and the Great Flood," 3; Ramírez, *Memoria acerca de las obras e inundaciones en la Ciudad de México*, 215-16; and Gurría Lacroix, *El desagüe del Valle de México durante la época novohispana*, 115; and Luis Flores, "Memorial del Padre Fray Luis Flores, año de 1653..." in *Obras públicas en México*, 3:99.

denunciation of Cortés' selection of the island for founding Mexico City. It is a criticism grounded in antiquity. Consider, for example, Vitruvius' ideas on choosing a location when establishing a new settlement:

> First comes the choice of a very healthy site. Such a site will be high, neither misty nor frosty, and in a climate neither hot nor cold, but temperate; further, without marshes in the neighbourhood. For when the morning breezes blow toward the town at sunrise, if they bring with them mist from marshes and, mingled with the mist, the poisonous breath of the creatures of the marshes to be wafted into the bodies of the inhabitants, they will make the site unhealthy.[72]

Vitruvius' words underscore the importance of choosing a site wisely. Simply put, Cortés' decision went against the Vitruvian code. It also went against the sound advice of his men, who warned the conquistador of the site's shortcomings.[73] Cortés' decision to settle the Aztec island capital meant that the new city would be continually exposed to flooding.[74] With the city in the midst of floodwaters, Philip's decree to relocate the settlement was prudent. Acknowledging the city's less than desirable location by relocating meant that Mexico City could finally free itself from the natural disasters that had plagued it since pre-Columbian times.

Relocating the capital was not as simple as decreeing its move. To consider Philip's wishes, viceregal authorities convened to discuss the matter. Imagine if you will, city leaders locked away in the chambers of city council, thousands of miles away from Spain, debating the benefits and drawbacks of the king's mandate. On the one hand, relocating the city was quite sensible in thought. On the other hand, the viceregal authorities would have to face pragmatic issues. For example, who would incur the economic losses of walking away from Mexico City and who would pay for its reconstruction? Who would build the new city on the mainland?

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[72] Vitruvius, *The Ten Books on Architecture*, trans. Morris Hicky Morgan (New York: Dover Publications, Inc., 1960), 17.
[73] Gibson, *The Aztecs Under Spanish* Rule, 368.
[74] *Ibid.*

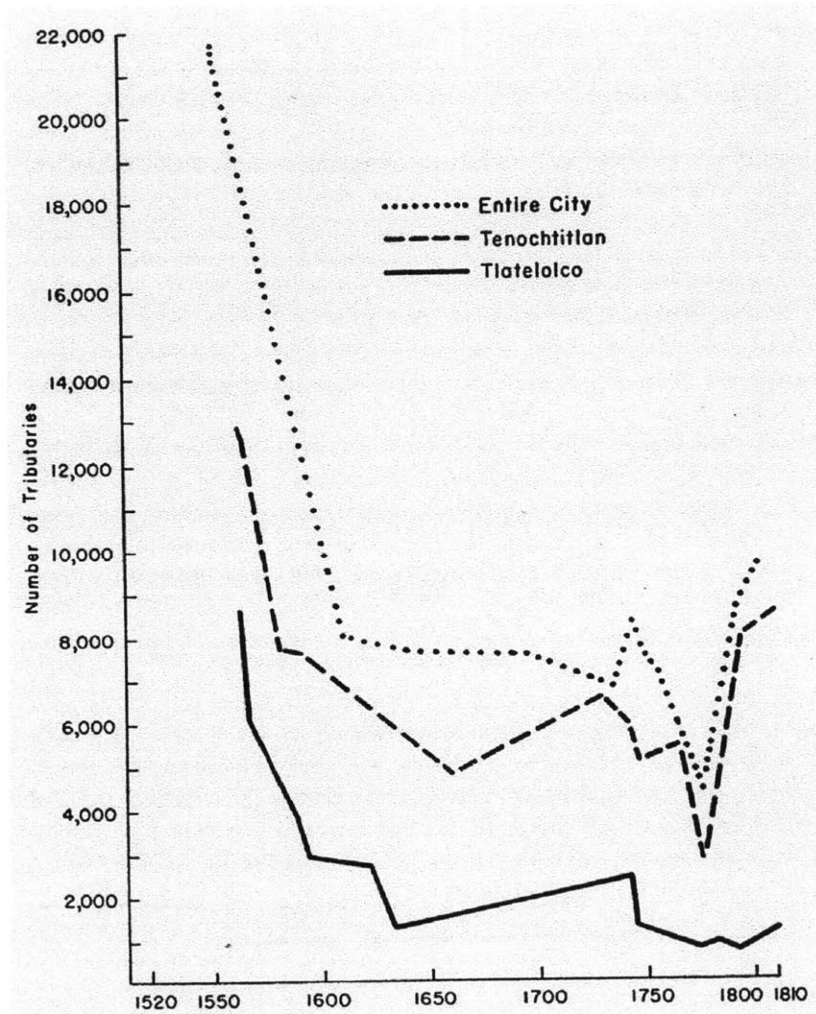

Fig. 9. Tributaries, Mexico City.

Another issue that weighed heavily on the minds of the colonial authorities was Indian labor. To be more specific, how to obtain an Indian workforce large enough to undertake the monumental task of building a new capital? In his table, Gibson shows a sharp decline in Mexico City Indian tributaries in the period leading up to 1600 (Fig. 9).[75] Although losses began to taper off after 1600, they nonetheless continued, albeit at a significantly lower rate. This drop was not

[75] *Ibid.*, 379.

Indian Tributaries by Political Jurisdiction

Jurisdiction[a]	*1570*	*1644*	*1692*	*1742*	*1763–1765*	*1782*	*1787–1794*	*1797–1804 (old)*	*1797–1804 (new)*
Chalco	13,050	2,910	2,689	5,071	5,180	6,372	7,182	8,623[b]	9,830[b]
Citlaltepec	6,600	661	720	1,206	1,021	902	745	1,362	1,596
Coatepec	2,400			827	845	842	1,118	1,319	1,543
Coyoacan	5,200	1,781	2,168	2,988	2,887		3,011	3,722	4,401
Cuauhtitlan	10,600	1,182	1,861	2,513	2,725	3,094	3,479	3,978	4,495
Ecatepec	2,600	362	260	1,024	1,631	1,834	1,762[c]	2,573	3,024
Mexicalzingo	2,420	462	318	882	825	1,585	1,761	2,222	2,518
Mexico	30,000[d]	7,631	7,631	8,400			8,893	9,672	12,061
Otumba	6,500	480	509	709	853	1,246	1,088	1,361	1,634
Tacuba	9,900	2,430	2,916	3,965	3,571	5,210	5,951	6,561	7,383
Teotihuacan				860	1,273	1,674	1,577	1,813	2,168
Texcoco	19,400	2,074	2,711	5,969	4,793	7,540	6,847	7,546	9,011
Xochimilco	8,600	2,686	2,783	3,440	4,314	4,730	3,666[e]	4,281	4,821
Total, Valley of Mexico	117,270	22,659+	24,566+	37,854			47,080	55,033	64,485
Total, New Spain[f]				316,099+ *(1729)*	397,900+ *(ca. 1770)*	458,251 *(1784)*	483,282 *(1794)*	676,683 *(1807)*	763,813 *(1807)*

Fig. 10. Indian Tributaries, Mainland and Mexico City.

limited to the island, but also paralleled a decline on the mainland.[76] From Gibson's research on the mainland population, Indian tributaries also underwent a similar decline during this period (Fig. 10). By 1644, tributaries, from Mexico City and the mainland, totaled 22,659, a mere one-fifth of what the basin counted on in 1570. The number of indigenous workers was in short supply and demand for them was high, regardless of environmental disasters. Flooding made even more evident the declining availability of tributaries. As a result, the question of relocating the city was not just one centered on economics, but also on the availability of Indian workers. A declining workforce could mean only one thing: building a new city was becoming ever less feasible.

[76] *Ibid.*, 136-143.

The decision whether to abandon Mexico City was a difficult one. The value of the capital's buildings alone was estimated at fifty million *pesos*.[77] One need only glance at Gómez de Trasmonte's bird's-eye view to appreciate the difficulty of the choice that the colonial authorities faced. Perhaps unwilling to walk away from the capital city without exhausting all other options first, another discussion ensued, which centered on improving the *desagüe*. After weighing Philip's mandate of a new settlement on the mainland against upgrading the *desagüe* at the cost of a mere four million *pesos*, the panel overruled the monarch by choosing the latter option.[78] The city would remain in its aquatic location, but not without undertaking two significant changes to the *desagüe*.

A Water Management Agency

Up till this point in the history of Mexico City colonial water management, the sitting viceroy, *Audiencia*, and *cabildo* shared bureaucratic control over flood prevention and the right to scrutinize any proposal that was put forth. As Hoberman has demonstrated, this collective responsibility over flood control was not seamless and was the basis for many misgivings between the branches of government.[79] The previous nearly eighty years had shown that flood control proposals, regardless of their method to manage water, were at the mercy of different political bodies and their interests. Business as usual could not continue, especially when the city was still inundated, and when the colonial authorities were in direct disobedience of Philip's mandate. In the eyes of the sitting viceroy, Rodrigo Pacheco y Osorio de Toledo, 3rd Marquis of

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77 Hoberman, "City Planning in Spanish Colonial Government," 224-225; Flores, "Memorial del Padre Fray Luis Flores, año de 1653," 99.

78 Hoberman, "City Planning in Spanish Colonial Government," 224-225.

79 Hoberman, "Bureaucracy and Disaster."

Cerralvo, if the *desagüe* were to finally overcome Mexico City's centuries-old battle against flooding, then it had to be liberated from the shortcomings of city government.

In 1631, Viceroy Cerralvo established the Office of the *Desagüe*. The powers of the office were broad, having the authority to requisition tools and materials and to conscript Indian labor, and with jurisdiction in all civil and criminal cases pertaining to the drainage.[80] Establishing an agency solely devoted to flood control was significant. While we can point to agencies devoted exclusively to water management in the Low Countries, with the polder boards and to their subsequent influence in other Europe countries, strikingly, a water management agency in colonial Mexico City was hitherto non-existent.[81] The founding of the Office of the *Desagüe* also suggests that drainage was more difficult than originally believed. Recall that authors of drainage schemes proposed immediate results with minimal effort to construct the *desagüe*, while achieving a long-term solution to flooding. Ultimately, the idea of a *desagüe* agency was born from the realization that drainage was a complex technological, financial, and jurisdictional problem, requiring the administrative oversight of a single agency.

Between 1631 and 1637, the superintendents of the *desagüe* derived from civic government. They were *oidores* (judges) of the *Real Audiencia* or *corregidores* (chief magistrates), such as Juan de Villanoba Cubiaurre who was appointed the *desagüe's* first supervisor. Juan Cevicos followed and was succeeded by Juan de Cervantes, who held the post between 1631 and 1635.[82] These secular appointments proved short-lived when on July 20, 1637, Viceroy Lope Díez de Aux de Armendáris, Marquis de Cadereyta, appointed Franciscan friar

[80] Candiani, "Draining the Basin of Mexico," 49-50.
[81] Danner et al., *Polder Pioneers*.
[82] Candiani, "Draining the Basin of Mexico," 51; Hoberman, "City Planning in Spanish Colonial Government," 230.

Luis Flores as the *desagüe's* superintendent.[83] Flores' appointment ushered in a period of Franciscan supervision known as the "Golden Age of the Desagüe," which lasted through 1691. Like their Jesuit counterparts before them, the Franciscan Order were given the task of saving Mexico City.[84] Yet the approach would be different: to convert Martínez' *desagüe* tunnel to a canal—the second change to the *desagüe*.[85] Converting the tunnel would be no easy task since it lay 149 feet below the surface of the earth at its deepest point.[86] Although the Franciscans are associated with the conversion, the origins of this idea lie elsewhere.

Geometrical Analysis of the Tunnel Conversion

In 1631, the Carmelite friar Andrés de San Miguel proposed converting the tunnel to a canal.[87] The reason for the conversion was simple. The tunnel suffered from frequent cave-ins, and thus blocked the passage of water. By transforming the tunnel into a canal, it was believed that collapses would be eliminated altogether, thereby allowing the waters to flow freely. San Miguel was aware of the *desagüe*, its origins, and shortcomings, having participated in discussions on the project since its inception in 1607. San Miguel served on the advisory committee that reviewed the various drainage proposals, including Martínez'. San Miguel left little doubt of his animosity towards the German cartographer when writing in 1631 a scathing critique of the *desagüe*. He criticized Martínez' engineering capabilities by stating that his

[83] Candiani, "Draining the Basin of Mexico," 51.

[84] In June 1627, the Viceroy Cerralvo turned to the Jesuit Order to reinforce many of the hydraulic elements protecting the city and to supervise the *desagüe*. Despite avoiding disaster in 1627, the city was not as fortunate in 1629, as already noted. See Musset, *El agua en el Valle de México*, 201; Chanfón Olmos, *Historia de la arquitectura y el urbanismo Mexicanos*, vol. 2, bk 3, 337-338.

[85] To assist, Flores recruited twenty-three members from his Order. Candiani, "Draining the Basin of Mexico," 56.

[86] Hoberman, "Technological Change in a Traditional Society," 167.

[87] San Miguel was born Andrés de Segura in 1577 in the town of Medina-Sidonia, five leagues from Cádiz. In 1594, he sailed for New Spain and eventually was stranded in Florida, where he vowed to join the Order of the Carmelites if rescued. In 1598, he joined the Carmelites in Puebla, taking the name Andrés de San Miguel. See Manuel Toussaint, "Fray Andrés de San Miguel, arquitecto de la Nueva España," *Anales del Instituto de Investigaciones Estéticas* 4, no. 13 (1945), 6-7.

profession as a printer was of divine origin, but that God had abandoned him when engineering the drainage project.[88]

That same year, San Miguel also wrote a report on the hydraulic state of Mexico City entitled "Relacíon del sitio, trabajos, y estado de la Ciudad de México, y de su remedio."[89] In it, he provided a general description of the *desagüe*, its canal, tunnel, shafts, and distances. As part of the report, San Miguel describes a flood control proposal—which he proceeds to discredit. This plan consisted of raising the elevation of the entire settlement by bringing soil from the mainland. The Carmelite believed that this plan would put an unwise financial burden on the city, since a *vara* of soil cost six *reales*.[90] Over and above the monetary concerns of the scheme, the friar had his doubts about its effectiveness. He noted that this strategy had already been employed with little benefit, city streets having been raised by two, and sometimes three *varas*, without preventing flooding. Hence, San Miguel believed that raising the elevation of the city would be both expensive and ineffective. In his view, ending inundations demanded more than the layering of new soil over old: it required mathematical reasoning. In the concluding pages of the report, we find his plan for converting the tunnel to a canal.

Andrés de San Miguel proposed a two-part scheme. The first phase involved digging a canal from Lake Mexico to the existing *desagüe* canal at the *Vertideros*, the spillway where the already diverted Cuautitlán River joined the *desagüe*.[91] Despite his animosity towards Martínez, this phase of the friar's plan is consistent with the second stage of Martínez' drainage proposal,

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[88] Andrés de San Miguel, "Informe dado en 1636-37 al Virrey Marqués de Cadereyta, acerca del Desagüe de Huehuetoca, por Fr. Andrés de San Miguel," in *Obras públicas en México*, 3:46; Toussaint, "Fray Andrés de San Miguel, arquitecto de la Nueva España," 10.
[89] Andrés de San Miguel, "Relacíon del sitio, trabajos, y estado de la Ciudad de México, y de su remedio." Refer to AGN, Desagüe, vol. 3 f. 329-361. For its published version, see Andrés de San Miguel, *Obras de fray Andrés de San Miguel*, 322-343.
[90] AGN, Desagüe, vol. 3 f. 332 v.
[91] Candiani, "Draining the Basin of Mexico," 78.

which went unbuilt. Technologically speaking, constructing a canal was not a difficult task and was thus a realistic goal. But before the canal could function properly, the natural terrain leading away from Lake Mexico, and the *desagüe's* canal and tunnel, had to be given a proper slope. Recall that Boot had identified a series of elevation miscalculations on the part of Martínez when studying the project in 1614. These had not been rectified in the time since the Dutchman's observations. If drainage was to begin from the lowest-lying point in the basin—Lake Mexico—then the natural terrain would have to be graded to slope away from the lake.

The second stage of San Miguel's scheme posed a quite difficult engineering challenge: to convert the tunnel to a canal. Transforming the *desagüe* tunnel to a canal would require more than shovels, buckets, and workers: it would necessitate an entirely new method for conceptualizing the problem of drainage. The removal of millions of cubic meters of soil required precise calculations. To understand this problem, San Miguel produced two geometric drawings (Fig. 11).[92] In one drawing located vertically on the page, the Carmelite friar made a series of four cross-sections, representing an equal number of segments between Lake Mexico and the exit point of the *desagüe* tunnel. The first section corresponds to the topography between Lake Mexico and the *Vertideros* (a distance of 35,750 *varas*); the second, to the area between the spillway and the mouth of the *desagüe* tunnel (some 8,260 *varas*); the third, from the mouth, along the tunnel, to its deepest point below the surface (another 3,000 *varas*); and the last section goes from this deep point to the tunnel's exit (an additional 2,950 *varas*).[93] In the second image (at the bottom of the page), San Miguel presents us with a trapezoid,

[92] These drawings can be located in AGN Desagüe: vol. 3, exp. 6, f. 33 or in San Miguel, *Obras de fray Andrés de San Miguel*.
[93] San Miguel, "Relacíon del sitio, trabajos, y estado de la Ciudad de México, y de su remedio," 342; Candiani, "Draining the Basin of Mexico," 79.

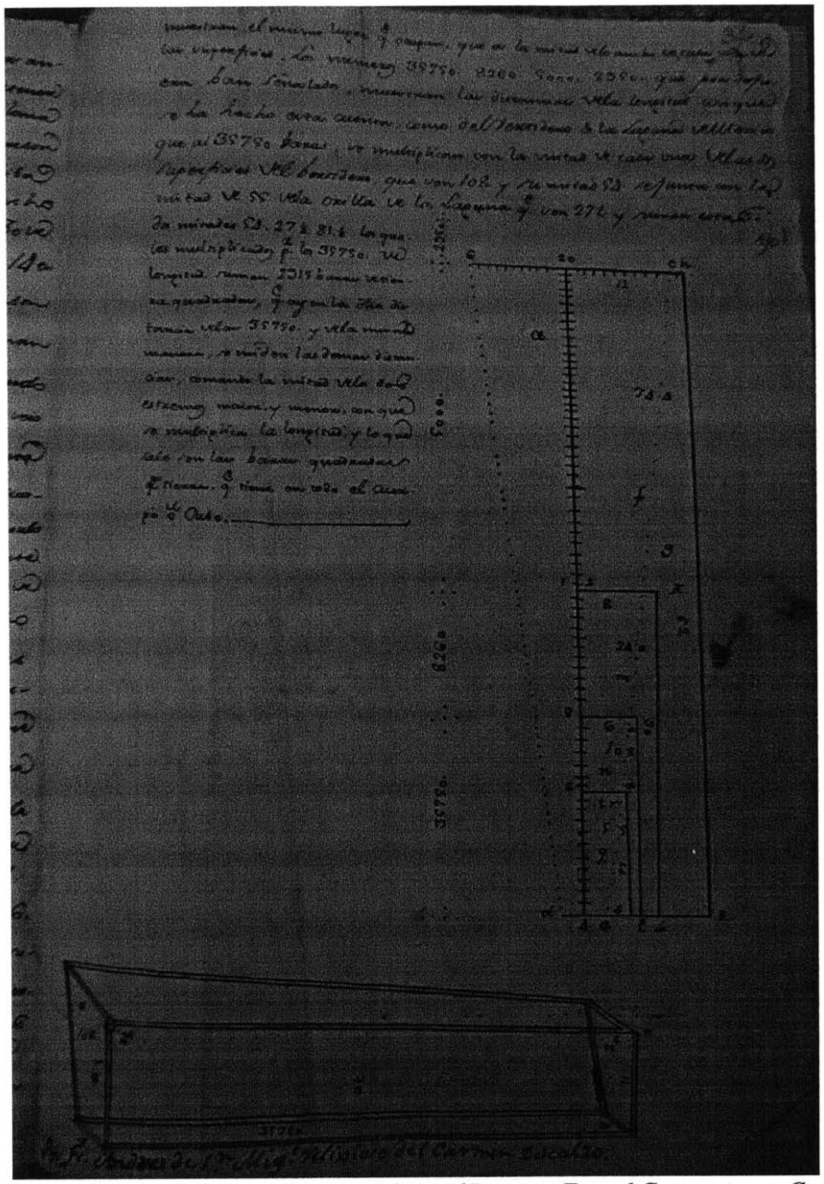

Fig. 11. Andrés de San Miguel, *Geometric Analysis of Desagüe Tunnel Conversion to Canal*, 1631
Source: Archivo General de la Nación. Desagüe: vol. 2, exp. 19, f. 33.

showing us the first two segments—from Lake Mexico to the mouth of the tunnel. Candiani has already explained the mathematical calculations by which San Miguel arrived at his figures, which does not need repeating here except for one important fact.[94] By depending on simple geometric figures to represent the tunnel in abstract terms, the friar estimated that 7,962,865

[94] Candiani, "Draining the Basin of Mexico," 79.

cubic varas (or 4,685,986 cubic meters) would need to be excavated to complete the conversion.[95]

The mathematical character of San Miguel's drawings is important. It should not come as a surprise, since the friar was a mathematician.[96] The drawing's economy in size and line stand out immediately, easily fitting on a page of high cotton fiber meant primarily for the written word. In noticeable contrast with the maps studied in this dissertation, San Miguel's images lack any embellishment such as color, decorative borders, cartouches, or legends—elements that any European mapmaker would find necessary when making a map. Equally as significant, the drawings do not portray the natural terrain of the basin, as was the case with Martínez' *Descripción de la comarca de México i obra del desagüe de la laguna,* nor do they purport to describe the geography of the city as did folio 2r of the *Codex Mendoza* or the *Nuremberg Map.* For the Carmelite friar, catastrophic inundation was not a problem posed to cartographic rendering, but rather, the economy of drawing demonstrates how a potential solution was deduced through mathematical abstraction. Bringing to an end the city's flood demanded that only the tunnel and canal come under the scrutiny of mathematical analysis, and to be more specific, under the lens of Euclidian geometry. For the friar, geometrical forms would embody the structure of the canal and tunnel, so much so that their respective area (not their volume) could be calculated from these hand-made drawings.[97] San Miguel's figures thus imply that a possible solution to flood control could be derived through theoretical means and not only through empirical observation. Despite the fact that the friar's plan had its own defects—the incline of the tunnel-turned-canal's walls was eighty-two degrees, which was too steep to prevent

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[95] *Ibid.* The figure of 7,962,865 cubic *varas* is based on Candiani's conversion of San Miguel's original figure.
[96] Toussaint, "Fray Andrés de San Miguel, arquitecto de la Nueva España," 6.
[97] Candiani has noted the friar's preference to provide measurements in term of their area and not their volume.

collapse, and the new slope of the tunnel intensified the speed at which water flowed, thus increasing erosion—his scheme attempted to resolve Martínez' engineering shortcomings when transforming the tunnel to a canal through mathematical deduction. In the words of *desagüe* historian Vera Candiani, San Miguel presented a plan in "pristine geometrical terms."[98]

"The Golden Age of the *Desagüe*"

San Miguel would seem like the most logical choice to head the *desagüe's* conversion; yet he was not chosen. Overlooking the Carmelite friar to lead the Office of the *Desagüe* is perplexing at first thought. After all, he presented a plan that would have rectified, in theory, the deficiencies of the *desagüe*, while at the same time converting the tunnel to a canal. To comprehend why the friar was bypassed to lead the agency, we must understand the relationship between the Franciscan Order and the basin's Indian population.

The Franciscans were favored over San Miguel for two reasons. First, the Order had the technological background to implement the Carmelite's plan. But more importantly, they already held administrative control over a large percentage of the basin's Indian population available for conscription given their proselytizing mission.[99] To put this point in greater perspective, of the three mendicant orders—Franciscans, Dominicans, and Augustinians—the Franciscans "dominated the missionary enterprise" in the Basin of Mexico.[100] The Franciscans began their missionary endeavors in New Spain as early as 1524 with the arrival of the Twelve Apostles. These twelve men ingrained the Order into the social, political, and economic fabric of the basin by choosing the leading Indian settlements—Tenochtitlan, Tlatelolco, Texcoco, Tlalmanalco,

[98] Candiani, "Draining the Basin of Mexico," 83.
[99] *Ibid.*, 52-64.
[100] Gibson, *The Aztecs Under Spanish Rule*, 99.

Doctrina	Tributaries	Clerics
FRANCISCAN		
Texcoco	8,000	5
Otumba	6,500	4
Xochimilco	5,800	3
Tacuba	4,700	4
Tlalmanalco	4,000	5
Cuauhtitlan	3,400	4
Tlalnepantla	3,400	3
Milpa Alta	2,800	2
Ecatepec	2,600	2
Huexotla	2,500	2
Calpulalpan	1,300	2
Chalco Atenco	550	2
TOTAL	45,550	38
DOMINICAN		
Coyoacan	4,400	5
Tepetlaoztoc	3,500	2
Tenango	2,500	4
Azcapotzalco	1,800	2
Chimalhuacan Chalco	1,800	4
Coatepec	1,600	3
Amecameca	1,500	2
DOMINICAN (cont.)		
Cuitlahuac	1,500	3
Chimalhuacan Atenco	800	3
Tacubaya	800	2
TOTAL	20,200	30
AUGUSTINIAN		
Acolman	4,100	2
Culhuacan	1,300	2
Mixquic	1,200	3
Tezontepec	800	2
TOTAL	7,400	9
SECULAR CLERGY		
Huehuetoca	4,800	1
Tizayuca	4,400	1
Tequixquiac	3,700	1
Zumpango	2,900	1
Hueypoxtla	2,700	1
Tepozotlan	2,400	1
Ixtapalapa	700	1
Huitzilopochco	420	1
Santa Fe	130	1
TOTAL	22,150	9

Fig. 12. Doctrinas, 1570.

Xochimilco, among others—as their centers for religious pursuits.[101] By extension, their pious interests gave them control over the indigenous populations within their ecclesiastical jurisdiction. In turn, this meant that the brotherhood managed indigenous tribute. By 1570, as noted by Gibson, all other clergy combined barely surpassed the Franciscans in the number of tributaries under their supervision (Fig. 12).

In pronounced contrast with the Franciscans' long and established history with the indigenous populace of the basin, the Carmelites had no *doctrinas*. A *doctrina* was an ecclesiastical center consisting of a principal town (*cabecera*), where church and clerical residences were to be found, which was surrounded by smaller Indian towns called *visitas*.[102]

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[101] *Ibid.*, 98.

[102] Candiani, "Draining the Basin of Mexico," 90; Gibson, *The Aztecs Under Spanish Rule*, 101.

Lacking this ecclesiastical structure, the Carmelites did not have a native populace under their supervision and thus lacked tribute workers. Administrative control over tribute workers is a point that cannot be underscored enough; without Indian workers no Spanish construction project could be undertaken. The administrative control over a large percentage of native tributaries ensured the selection of the Franciscan Order to supervise the *desagüe*.

On August 20, 1637, only a month into his superintendency, Flores began the conversion.[103] Despite the fact that San Miguel was bypassed to lead the *desagüe*, his imprint can be found at every level of the conversion. For example, San Miguel, according to Candiani, proposed to apply Aristotle's theory of elements in the conversion, using the force of water to aid in removing excavated earth.[104] The plan was quite simple: to allow the excavated debris to fall into the bed of the tunnel so that the rushing water below would flush it out of the basin. The Carmelite friar's idea is also a labor-saving scheme. Once more, think about Indian tributaries in decline, but now do so in the context of San Miguel's plan. Instead of thousands of workers moving millions of baskets of soil, mud, or rock for miles in converting the tunnel, the natural debris could be carried away by harnessing the natural energy of rushing water. The idea is elegant in its simplicity. But however ingenious, San Miguel's proposition was not functional year-round.

Debris removal via rushing water requires a large force provided only by a fast-moving current. Ironically, such a plan could only be operational during the rainy season (June to September) when the city was at the greatest risk of inundation. During the rest of the year, debris removal employing this method was impossible. There was simply not enough rain in the basin to move a clump of dirt. To continue working on the tunnel's conversion during the non-

[103] Gurría Lacroix, *El desagüe de Valle de México*, 133.
[104] Candiani, "Draining the Basin of Mexico," 85.

Date	*Cause*	*Date*	*Cause*
1616, June 11	drought, famine, disease	1656, Nov. 12	flota peril
1639, July 2	disease, famine, peril of flota	1661, June 14–15	drought
1641, June 13	drought, famine, disease	1663, June 17–29	drought, heat, disease
1642, Aug. 31	drought, famine, disease, royal wars	1667, May 11	drought, disease
1653, June 17	drought, heat, disease	1668, June 13	drought, disease
1656, Sept. 16	English attacks in the Caribbean	1678, May 30	drought, disease
		1685 (1686?), June 2	drought, famine
		1692, May 24	famine
		1696, Aug. 28	peril of flota at Havana

Fig. 13. Virgin of Remedios Processions to Mexico City in the Seventeenth Century.

rainy season, Flores introduced "sluice-bursts," a variation of San Miguel's rushing water model. Sluice-bursts entailed building a temporary dam to hold back any available water until a large enough amount was amassed, at which time it would be released to sweep away the accumulated debris resting in the bed of the tunnel.[105] If successful, the rubble would be swept away. In the worst-case scenario, the rubble would be pushed further down the tunnel or not at all. This last point leads us to consider another limitation of the sluice burst. During the non-rainy season, excavation had to be calculated. In other words, the amount of rubble could not be so large that the force produced by the sluice burst could not wash it away. Moreover, sluice bursts would not have been a common practice from year to year since Mexico City continually suffered from droughts. During the period of Franciscan supervision over the *desagüe*, Remedios was brought to the capital no less than nine times, according to Gibson's table (Fig. 13). With drought, sluice bursts were impossible. The soil, mud, and rock that lay in the bed of the tunnel would have to wait until Remedios performed a miracle by making it rain.

As we can begin to comprehend, the conversion was not going to happen overnight. In his twenty-two years as superintendent (1637-1659), Flores converted 3,587 *varas* of the tunnel

[105] *Ibid.*, 86-87.

to canal, shored up 1,500 *varas*, and deepened 18,000 *varas* of the tunnel by 2 *varas*.[106] Between 1665 and 1675, Franciscan friar Manuel Cabrera supervised the *desagüe*, converting 2,196 *varas* of the tunnel.[107] In 1687, the tunnel was deepened to 198 feet, in the belief that a greater slope would allow more water to be drained.[108] Finally, in 1691, at the end of Juan Romero's short tenure, the Franciscans ceded control of the *desagüe*.[109] With the appointment of Pedro Labastida, the drainage project returned to the jurisdiction of civil authorities.[110]

Conclusion

While we cannot be sure to what extent the Franciscans altered the lacustrine environment, no late seventeenth-century image is more indicative of their goal than *La mui noble y leal Ciudad de México*, an anonymously authored painting from ca. 1690 (Figs. 14 & 15). Located in the Museo Franz Mayer in Mexico City, it is painted on a *biombo*, a Japanese folding screen, consisting of ten panels and measuring a total of 563 x 213 centimeters.[111] A freestanding screen, it is one of four known *biombos* portraying Mexico City. Each depicts the Spanish conquest of Tenochtitlan in 1521 on one side and late seventeenth-century Mexico City on the other.

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106 Gurría Lacroix, *El desagüe de valle de México*, 134.
107 *Ibid.*
108 Hoberman, "City Planning in Spanish Colonial Government," 102.
109 Candiani, "Draining the Basin of Mexico," 51. The notable exception to Franciscan supervision is the superintendency of Martín Solis. Solis gained control of the *desagüe* in 1675 by complaining of the Franciscans' lack of progress, but lost it to the Order in 1687, when his shortcomings as an engineer caused cave-ins (*ibid.*).
110 Candiani, "Draining the Basin of Mexico," 51. See others in Candiani's note 4.
111 *Biombos* are Japanese folding screens that arrived in New Spain via trade routes from the Philippine Islands. The Japanese *shōgun* Tokugawa Ieyasu sent the first documented *biombo* to New Spain in 1610 and later shipped up to ten more to the viceroy in 1614. These folding screens varied in length, ranging from four to twenty panels and in height from one and one-half meters to two. They could be found in various places in a home, such as parlors (*biombos rodastrados*) and bedrooms (*biombos de cama*). See Kelly Donahue-Wallace, *Art and Architecture of Viceregal Latin America, 1521-1821* (Albuquerque: University of New Mexico Press, 2008), 211-17. For a discussion of *biombos*, also refer to Sofía Sanabrais, "The *Biombo* or Folding Screen: Examining the Impact of Japan on Artistic Production and the Globalization of Taste in Seventeenth-Century New Spain" (Ph.D. diss., New York University, 2005).

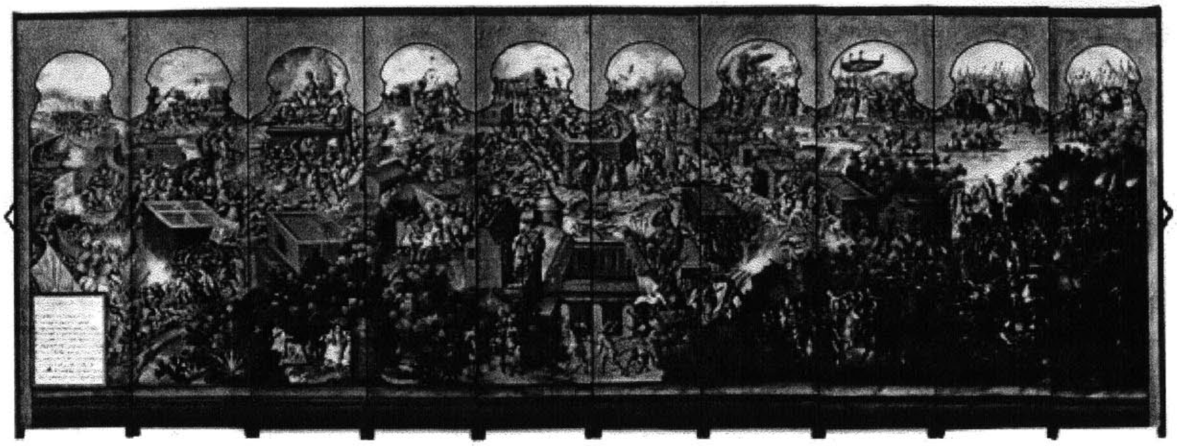


Fig. 14. Anonymous, *La mui noble y leal Ciudad de México* (recto), ca. 1690, oil on canvas, 18 ft. 5 in. x 6 ft. 10 in. x 3/4 in. (5.63 x 2.13 m. x 2 cm). Museo Franz Mayer, Mexico City. Photograph by Michel Zabé. Photograph provided by the Museo Franz Mayer, Mexico City.

Fig. 15. Anonymous, *La mui noble y leal Ciudad de México* (verso), ca. 1690, oil on canvas, 18 ft. 5 in. x 6 ft. 10 in. x 3/4 in. (5.63 x 2.13 m. x 2 cm). Museo Franz Mayer, Mexico City. Photograph by Michel Zabé. Photograph provided by the Museo Franz Mayer, Mexico City.

In *The Art of Allegiance*, art historian Michael Schreffler argues that the Franz Mayer *biombo*'s later rendition of Mexico City demonstrates its loyalty to the Spanish king.[112] He identifies the place from which the city is seen by offering that the viceroy, and by extension, the

[112] Schreffler, *The Art of Allegiance*, 25.

Spanish monarch, surveys the city from the mainland palace at Chapultepec.[113] An architectural detail in the *biombo* further supports Schreffler's argument. In the folding screen, a tripartite border runs along three sides of the image. It consists of a wide and lavishly adorned border at the center flanked by two narrow and plain borders on either side. However, the lower edge of the painting is treated distinctively. What appears to be the top of a handrail extends from one end of the painting to the other. The handrail functions symbolically, likely representing a balcony. Furthermore, it posits that Mexico City was no longer to be observed from a disembodied viewpoint, that is, the bird's-eye view as in Trasmonte's *Forma y levantado de la Ciudad de México*, but rather from the perspective of a discriminating eye. Trasmonte's bird's-eye view provided a nondescript picture of the city's buildings, save for its most important structures, as an indication that one was meant to see the capital city from a great distance. In marked contrast, the *biombo* presents a legible view of architectural details, such as the merlons of crenellated parapets, doors, windows, and courtyards, suggesting a discerning viewer.

La mui noble y leal Ciudad de México employs many of the visual cues used in *Forma y levantado de la Ciudad de México*. Both views originate from an elevated westerly position and look eastward across the city. Both incorporate a legend in the lower left-hand corner, and each highlights the city's urban grid and architectural fabric. And yet, the bird's-eye view and the *biombo* are notably different. In *Forma y levantado,* one reads the city as part of a larger geographical expanse of lakes, mountains, and volcanoes. However, in the folding screen, the city occupies nearly every inch of the canvas. Topographical features receive little attention. By inverting the relationship between the city and its natural surroundings, the author of the Franz

[113] *Ibid.*

Mayer *biombo* demands one's undivided attention. In doing so, it impresses upon the viewer that the capital is no longer an island, but rather a mainland settlement.

Notice how Lake Texcoco is nowhere to be found. The vast lacustrine environment that overwhelmed the city for centuries has been reduced to two harmless bodies of water flanking the settlement. Historically, floodwaters came from an easterly direction, originating in Lake Zumpango and eventually making their way to Lake Texcoco before inundating the city. By giving the impression that Texcoco is no more, the *biombo* simply wishes away any threat of flooding. With this illusory safety, there is no need to describe the extensive hydraulic network of dikes, canals, and causeways that helped safeguard the city. As a result, the dike of San Lázaro garners no attention, and the causeways and canals of the city receive minimal consideration from the *biombo's* author.

The relationship between city and monarch is clear. Schreffler, like Alejandro Cañeque in *The King's Living Image: The Culture and Politics of Viceregal Power in Colonial Mexico*, argues that the viceroy embodied the king in New Spain.[114] In *La mui noble y leal Ciudad de México*, the personification of the monarch is located at the palace at Chapultepec from which Mexico City is seen. However, this is not the city offered in Trasmonte's *Forma y levantado*. The *biombo*'s pictorial narrative offers a new image of late seventeenth-century Mexico City. It frames its allegiance to the monarch through the portrayal of the capital's new environmental condition brought about by the *desagüe*. The attention devoted to describing the city, the area it occupies in the *biombo* at the expense of topographical features, such as Lake Texcoco, and thus the illusion of safety it offers—all suggest that the *desagüe* had finally liberated Spain's New

[114] Cañeque, *The King's Living Image*.

World capital from its chronic battle against flooding, transforming the island city into a secure mainland settlement.

With a colonial ideology in mind, one can recognize that *La mui noble y leal Ciudad de México* offered a new vision of Mexico City and its relationship to the lakes. Read together with the conquest of Tenochtitlan on its reverse, the *biombo's* portrayal of the city underscores the wresting of the Aztec city from pagan hands and its transformation into the locus of Spanish viceregal society. Historian Kevin Terraciano has argued that the *biombo's* two sides represent the "dawning of a new age."[115] This "new age" was dependent on solving the age-old problem of the city's susceptibility to flooding. When viewed in this light, *La mui noble y leal Ciudad de México* presents a picture of environmental change—change in which the challenges posed by Mexico City's natural setting and its historical path of development had been overcome by the *desagüe*.

[115] Kevin Terraciano, "Competing Memories of the Conquest of Mexico," in *Contested Visions in the Spanish Colonial World*, ed. by Ilona Katzew (Los Angeles: Los Angeles County Museum of Art, 2011), 74.

Conclusion

Tenochtitlan's and later Mexico City's historical path of development centered on water management. The island site's susceptibility to flooding demanded that the Aztec and Spanish develop methods for mitigating inundations. As we have seen, the two groups' approaches—regulation for the former and drainage for the latter—could not have been more diametrically opposed. While the Aztec managed the lacustrine environment by building dikes, causeways, and floodgates, among other hydraulic structures, the Spanish relied primarily on drainage and re-routing problematic rivers to end the chronic problem of flooding.

Each method produced a different urban environment. Tenochtitlan was a city made with water in mind. Recall that, from its founding, water ordered the spatial arrangement of the pre-Columbian settlement's quadripartite plan. In the folio 2r of the *Codex Mendoza* we learned how the canals that intersected the eagle perched on top of a prickly pear cactus were made manifest in the urban fabric portrayed in the *Nuremberg Map*. Moreover, the city's formal organization was grounded in cosmological authority, replicating the order of the pre-Columbian universe.

The island site had its limitations. Settling the island exposed the Aztec to flooding, and its limited land base made agricultural production and urban expansion difficult. Resolution to these three issues would come through hydrological means. A hydraulic network, in theory, would end flooding and, by extension, aid food production and urban growth. Inundations destroyed *chinampas*. Establishing a controlled aquatic environment meant that a steady and constant flow of foodstuffs would go towards the pre-Columbian imperial city. Employing the same technology used in building raised fields, the Aztec reclaimed land from the lakes, increasing the island by at least five times its original size.

In contrast, the viceregal authorities saw no inherent value in the lakes. For them, the risk of disaster was too great to leave Mexico City as an island. Believing that flooding would end when the lacustrine environment was eliminated, they undertook drainage. Not unlike the way the pre-Columbian water management method shaped Tenochtitlan, the *desagüe* also dictated the urban form of viceregal Mexico City. The *desagüe's* only goal was to prevent the city from flooding, but its effect upon the watery landscape was great. Proponents of the *desagüe* wanted to empty the lakes; yet doing so would result in reclaiming land. Wresting land from the lakes was never the objective, but once the waters were made to recede, the island and mainland were united, as suggested by the anonymously authored *biombo* painting of the late seventeenth century.

Historical images have provided us with a more nuanced comprehension of the hydrographic story of the island site. These images were made for different purposes, by different people, and over the course of two centuries. However, when considering them thematically, we can begin to understand the importance of flood control to the Aztec and Spanish and its effects upon the urban forms of their respective cities. Ultimately, the images studied in this dissertation describe how each group conceived of their city's aquatic condition and the epistemological roots of their flood control approaches. Equally as important, scrutinizing the provenance of these images has allowed us to reflect upon key shifts in colonial water management practices. The assessment of property, taxation, and the creation of a flood control office in the seventeenth century speak to a changing administrative landscape. This change was predicated on the idea that raising funds, managing labor and resources, and eliminating instability would facilitate drainage, and by extension, save Mexico City from catastrophic inundation.

Flooding did not end with the close of the seventeenth century. Under Bourbon rule, viceregal authorities combated inundations by continuing the conversion of Martínez' *desagüe* tunnel to a canal, an engineering feat that was not completed until 1785. The cost was great. In the 152 years required to transform the tunnel, over 200,000 workers lost their lives—and for naught: this new stage of drainage never prevented the city from flooding. In 1878, nearly one hundred years after completion of the conversion, Mexican President Porfirio Díaz commissioned a series of new drainage tunnels: the Grand Canal and the Túnel de Tequixquiac. Technologically vastly superior to any drainage tunnel previously built, these discharge channels were based on the same principle as Martínez' *desagüe*: they were to drain the lakes. They also failed to end flooding. Today, another drainage tunnel has been heralded as the great savior of Mexico City. The newest hope is that the Túnel Emisor Oriente—constructed at a cost of 13 billion *pesos*, having a length of 62 kilometers, and with the capacity to discharge 150 meters^3 of water per second—will end the inundations that afflict the city. Not unlike their predecessors, today's engineers view drainage as the only real solution to the city's chronic flood problem.

The logic behind drainage is that it will end flooding. Nothing could be further from the truth. Present-day Mexico City continues to flood. Perhaps even more importantly, the rate of inundation has increased. Since 1950, the city has flooded no less than 76 times (more than once a year), a huge increase of frequency over the 13 inundations that occurred between 1429 and 1700 (less than once every twenty years). The reasons for flooding today are more complex than in past centuries. Recall that land reclamation was an unintended consequence of drainage. From four diagrams of Mexico City provided by Fox (1965), we can glean that in 1900 the size of the settlement remained nearly the same as in the early sixteenth century (Fig. 1). Yet by 1963, we can see that the city had expanded into the former lakes and was projected to grow into Lake

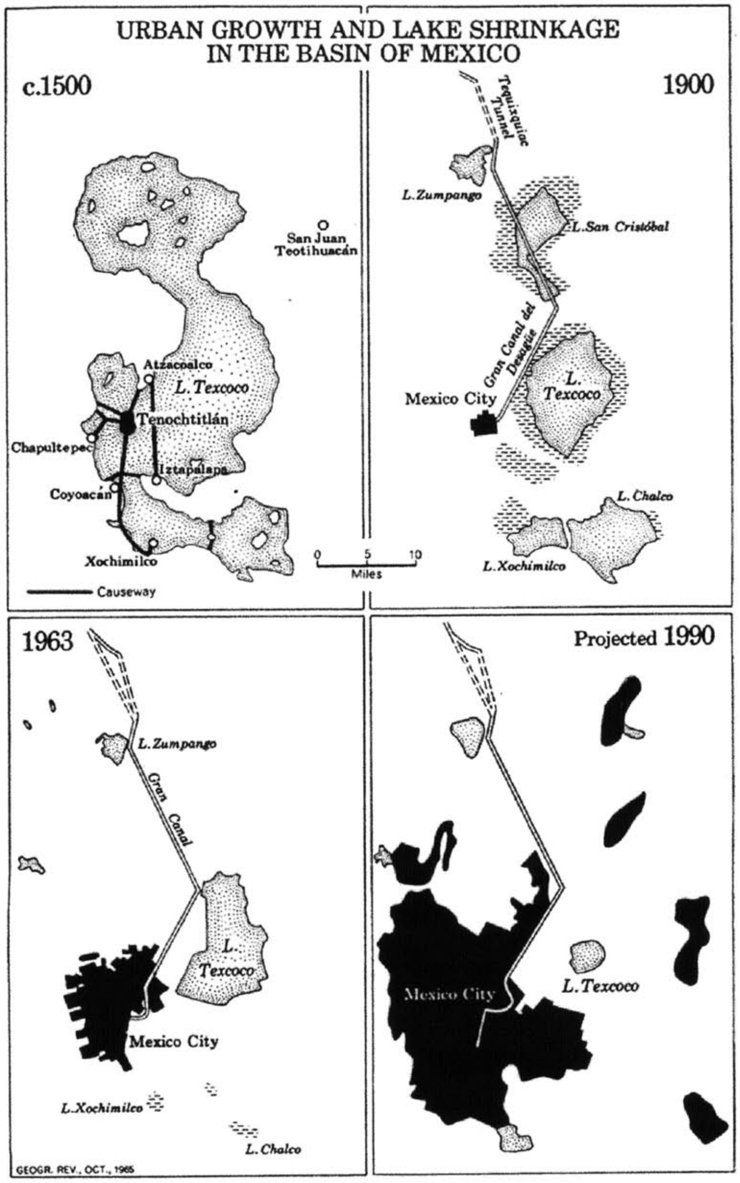


Fig. 1. Lakes in Relation to Mexico City's Urban Development

Texcoco as this body of water was made to recede. Perhaps no picture better captures the extent of urban sprawl than the Conabio satellite image of Mexico City (Fig. 2). Shockingly, human development has overtaken the basin floor. Only the mountains have impeded unbridled expansion.

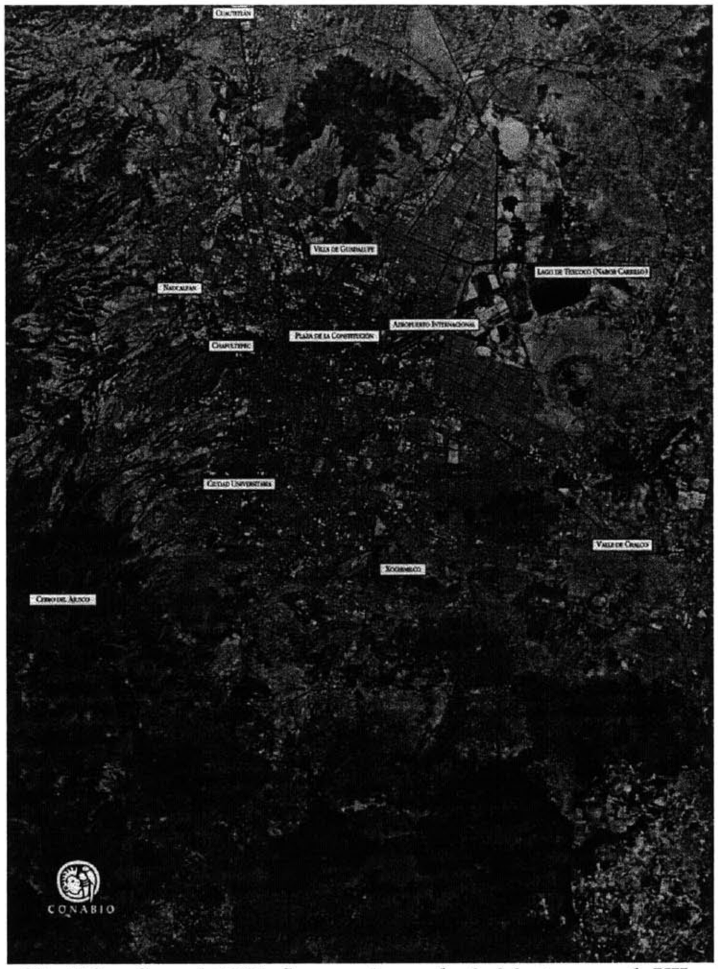
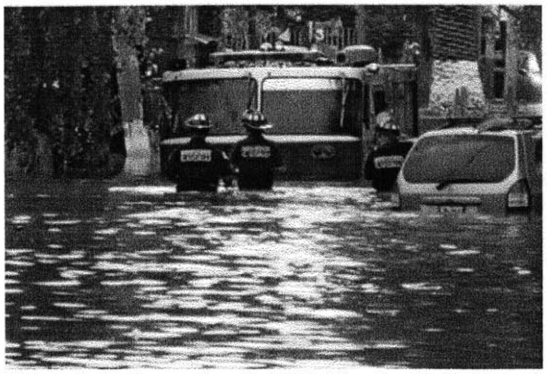
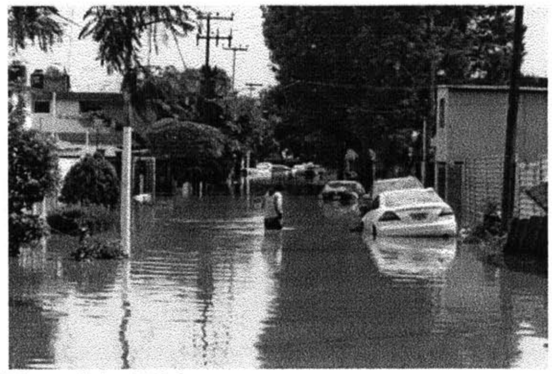


Fig. 2. Mexico City Urban Sprawl, 2004. Source: *Arqueología Mexicana*, vol. XII, no. 68 (2004), 18.

Urban sprawl into the former lakebeds has increased flooding. Hindsight makes us aware that Adrian Boot was correct in his assessment of drainage. Although drainage outlets have been built, their inclines have inverted due to subsidence, a phenomenon that Adrian Boot warned would occur when he assessed Martínez' *desagüe* in the early seventeenth century. With gravity no longer the primary means of discharging water from the basin, pumping stations, located throughout the city, attempt to keep the city dry under normal rainfall. But unlike when Tenochtitlan, and later viceregal Mexico City, flooded with water, present-day Mexico inundates with human waste. Unwisely, drainage tunnels perform a double duty: they carry the waste of the



Figs. 3 & 4. September 6, 2009, Flood at Valle Dorado. Photo: John F. López

third-largest agglomeration in the world and are expected to prevent flooding. When rainfall is above average, drainage tunnels are stressed beyond their capacity, breaking under the weight of their contents. On September 6, 2009, Valle Dorado flooded in human waste (Figs. 3 & 4). Although drainage engineers have changed the environmental condition of Mexico City, the probability of flooding remains.

A comparative study of Aztec and Spanish hydraulics is absent from the scholarly literature. Understanding the city's aquatic condition in the pre-Columbian and colonial eras is vital to explaining the formal and theoretical differences in flood control approaches between these groups. These differences are significant because they dictate how the respective cities were planned. Studies of Aztec and Spanish hydraulics have failed to suggest in any comprehensive manner how changes in the lacustrine environment affected the urban form of these cities. Surprisingly, no book on this subject exists in the English- or Spanish-speaking worlds. Perhaps most important of all, "The Hydrographic City" may aid in solving Mexico City's flood problems by providing a historical perspective on how and why the city still floods

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