Addressing climate change through community organizing and machine learning

by

Brandon Leshchinskiy

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Abstract

Climate change is the challenge of our time. It is global, slow-moving, and impersonal – yet it has already impacted everyone from California to Kuwait. Humans are ill-adapted to this type of problem, as the scale – both in time and space – is too large to spur action. But to ignore the difficult choices ahead poses a catastrophic threat to humanity. To address the climate crisis – to mobilize societal change – we must make it meaningful to both decision-makers and the public.

In this thesis, I investigate two aims. Aim one is developing EarthDNA Ambassadors, a community that “ripen” the issue of climate change by connecting leaders, empowering students, and engaging the world on climate. Aim two is developing the Earth Intelligence Engine, which uses AI to generate satellite images of the future, bridging the gap between AI experts, climate models, and decision-makers – starting with floods, the most frequent disaster in the US.

I developed and deployed training materials with dozens of young people to address the need for climate leaders. Surveys show the Ambassadors training program not only improves participants’ negotiation and communication skills, but also improves their mindset for learning leadership. Furthermore, EarthDNA’s Climate 101 workshop improves climate literacy and climate behaviors, and although long-lasting change is unlikely after one session, Climate 101 creates a privileged moment in which participants are more likely to increase their involvement in climate activism.

Working with a team, we also developed an initial framework for the Earth Intelligence Engine (EIE) to generate satellite imagery of future floods. The EIE outperforms both our handcrafted baseline and state-of-the-art AI models. We intend to deploy our flood visualization model with the National Oceanic and Atmospheric Administration (NOAA) – integrating flood forecasts with aerial imagery along the entire US East Coast – and then to expand to other areas and events.

Ultimately, climate change requires a mobilization of society at all levels. It demands both technical and adaptive work: new technologies and policies, yes, but also new ways of looking at ourselves and our world. Mitigating our climate crisis hinges on progress in complementary areas: inequity, polarization, and institutional backsliding. Climate change demands that we address many of the world’s most pressing issues – and it will take all of us to succeed.

Thesis Supervisor: Dava Newman
Title: Apollo Program Professor of Astronautics
Director of the MIT Media Lab
Harvard-MIT Health Sciences and Technology
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1. Introduction

Climate change is the challenge of our time. It is global, slow-moving, and impersonal – yet it has already impacted everyone from California to Kuwait. Humans are ill-adapted to this type of problem, as the scale – both in time and space – is too large to spur action (Jasanoff, 2010). But collective inaction, comfortable as it may seem, poses a catastrophic threat to humanity. To address climate change, we must make it meaningful and relevant to decision-makers and the public.

How can we make the impacts of climate change personal? How can we help people grasp – in their heads and in their hearts – the damage we are doing to our oceans, our coasts, and our futures? Ultimately, how can we build the political will for regulatory, legislative, and other social action? The effort required to face this challenge includes both technical work – new technologies and new policies – as well as adaptive work – shifts in values, habits, and assumptions (R. Heifetz, Grashow, & Linsky, 2009).

There are many opportunities to engage the public. Most pressingly, there is a huge contingent of people for whom climate change is not yet a “ripe” issue. In 2019, only 31% of Americans were truly “alarmed” by climate change – they viewed it as an urgent threat and they strongly supported climate action – and even among this group, most people didn’t know what they could do to solve the problem (Leiserowitz, 2019). Building the political will to mitigate and adapt for climate change requires ripening the issue for the general public, as well as equipping the alarmed segment with the tools needed to engage in adaptive work.

![Figure 1. A majority of Americans are now alarmed or concerned about climate change (Deeg, Lyon, Leiserowitz, Maibach, & Marlon, 2019).](image-url)
Figure 2. According to the Yale Climate Opinion Maps (Howe, Mildenberger, Marlon, & Leiserowitz, 2015a), a majority of Americans believe that climate change is a threat and want the government to take action.

Nonetheless, only 7 percent of the alarmed segment say they are part of “a campaign to convince elected officials to take action to reduce global warming,” while 28 percent say they “definitely would join” a campaign, and 37 percent say they “probably would join” such a campaign [citation]. Leiserowitz writes, “This represents an enormous potential social movement—if they were recruited, organized, and deployed.”
Even for decision-makers like governors, mayors, and commanders – people who can access qualified experts – climate impacts can still be non-intuitive and non-personal, preventing meaningful action. When it comes to flooding, for example – the most frequent disaster in the US (Centre for Research on the Epidemiology of Disasters & UN Office for Disaster Risk Reduction, n.d.) – experts rely on informative, but complicated visualizations to communicate risks.

Figure 3. An output of NOAA’s Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model, which is often used to inform disaster planning and response (Jeleñianski, Chen, & Shaffer, 1992). It is highly informative, but could be supplemented with visuals that make flood risks more intuitive and meaningful to those who aren’t used to consuming information from flood maps.

A “Google Earth for Climate Change” could help experts communicate climate impacts more effectively to those with the power to take action. Google Earth has taken a step in this direction with its time-lapse feature, which allows users to see how a location has changed over nearly 40 years. Imagine, however, a set of visualizations that move into the future as well as into the past. Google Earth Engine, Earth on AWS, and IBM PAIRS can help with processing past data and providing climate predictions, but there is no tool
that applies these predictions to offer images of potential futures. Obviously such predictions would be uncertain, but an ensemble of potential futures would still support better decision-making.

Figure 4. Google Earth’s new time-lapse feature allows users to see how an area has changed over time. The Earth Intelligence Engine aspires to supplement this functionality with images of the future.

In this thesis, I investigate two aims. Aim one is developing EarthDNA Ambassadors, a community that ripens the issue of climate change by empowering students, connecting leaders, and engaging the world on climate. Aim two is developing the Earth Intelligence Engine, which generates satellite images of the future, bridging the gap between machine learning, climate models, and decision-makers – starting with floods.

This thesis is organized as follows. Chapter two offers a background on climate change from the perspectives of science, media, and politics. In particular, it shows that scientists have accumulated decades of evidence for anthropogenic climate change and its harmful consequences, but that Americans remain fairly unperturbed by climate change due to a combination of factors. Climate change is a complex problem that’s inherently difficult to grasp, systemic challenges pervade the media ecosystem, and special interests sowed doubt to prevent regulatory action. Moreover, special interest groups funded politicians who were already opposed to government interventions – conservatives – which further polarized and muddied the
issue in the eyes of the public. Finally, even climate-friendly politicians have been largely unable to enact reforms that would help keep Earth below two degrees of warming.

Chapter three reviews literature on community organizing, climate education, and leadership. In particular, organizers turn communities with shared interests into constituencies with the power to create change. They do this by building relationships, telling stories, creating structure, devising strategy, and taking action. Furthermore, climate education is an overlooked, but key opportunity to address climate change, as young people make ideal messengers. The education sector, however, is not yet ready to teach about climate change. Researchers have developed recommendations both for institution-level reform and for curriculum-level reform. Finally, leadership is love. To be effective, leaders need negotiation, communication, and storytelling skills. Communication means getting messages across, not just information. Negotiation means balancing assertiveness and empathy. Storytelling means sharing key moments of pain and hope that connect with listeners. Self-awareness, both external and internal, underpins these practices.

Chapter four summarizes and discusses the research results of the EarthDNA Ambassador program. EarthDNA has recruited dozens of Ambassadors, providing a valuable community for climate leaders to support each other personally and professionally. Furthermore, EarthDNA’s leadership program improves Ambassadors’ skills at negotiation and communication, as well as cultivating growth mindset. As one Ambassador shared anonymously, “While the focus may be climate change, [the training program] teaches skills that are helpful in every facet of life.” Finally, EarthDNA’s Climate 101 workshop improves climate literacy and behaviors. While it seems unlikely that a one-time intervention would producing lasting change, Climate 101 creates a “privileged moment” in which participants are more likely to increase their involvement in climate activism.

Chapter five reviews literature on the application of machine learning (ML) for Earth, with a special focus on generative models, then summarizes and discusses the results of the Earth Intelligence Engine. In particular, we apply generative adversarial networks (GANs) to ease communication between experts and decision-makers for flooding. Generative adversarial networks are a new type of neural network that can generate images and other data. We train a GAN to create physically-consistent, photorealistic satellite imagery of future flooding. More precisely, our GAN combines a pre-flood image and a physics-based
input – a “segmentation map” – to generate a post-flood image. Training data comes from the xBD data set (for satellite images) and NOAA’s SLOSH model (for flood predictions). To assess our results, we combine two metrics into a Flood Visualization Plausibility Score (FVPS), which accounts for both photorealism and physical consistency. Our GAN outperforms other GANs and a handcrafted baseline. Furthermore, our GAN learns that flooded vegetation looks greener and that elevated structures don’t get flooded, and it produces photorealistic images even given a low-resolution flood prediction.

Finally, chapter six concludes with a review of the work, along with implications and suggestions for the future. Both EarthDNA Ambassadors and the Earth Intelligence Engine offer exciting prospects for development. If successful, EarthDNA could serve as a hub for training climate leaders around the world. We also aim to deploy our flood visualization model with NOAA – integrating flood forecasts with aerial imagery along the entire US East Coast – and then to expand to other areas and events. Ultimately, climate change demands that we address many of the world’s most pressing issues – and it will take all of us to succeed.
2. Background on Climate Change

Chapter two offers a background on climate change from the perspectives of science, media, and politics. In particular, it shows that scientists have accumulated decades of evidence for anthropogenic climate change and its harmful consequences, but that Americans remain fairly unperturbed by climate change due to a combination of factors. Climate change is a complex problem that’s inherently difficult to grasp, systemic challenges pervade the media ecosystem, and special interests sowed doubt to prevent regulatory action. Moreover, special interest groups funded politicians who were already opposed to government interventions – conservatives – which further polarized and muddied the issue in the eyes of the public. Finally, even climate-friendly politicians have been largely unable to enact reforms that would help keep Earth below two degrees of warming.

2.1. Science

Scientists have accumulated decades of evidence for anthropogenic climate change and its harmful consequences.

In 1896, Svante Arrhenius published *On the Impact of Carbonic Acid in the Air upon the Temperature of the Ground*. It was the first description of the greenhouse gas effect – when carbon dioxide allows sunlight into the atmosphere, but prevents the converted heat from escaping. Seventy years later, a report by Lyndon B. Johnson’s Science Advisory Committee concluded to the president, “The climactic changes that may be produced by the increased CO\textsubscript{2} content could be deleterious from the point of view of human beings” (United States, 1965). It was the world’s first government report on climate change.
The authors of LBJ’s report granted that “climactic ‘noise’ from other processes… at least partially masked any effects on climate due to past increases in atmospheric CO2 content.” In the early 1980s, however, scientists predicted climate change would be detectable – that is, it would “emerge” from this noise – by the end of the century (“The Discovery of Global Warming,” 2019).

They were right:
Today, climate change has become a reality. NASA records indicate that, due to rising surface temperatures, Earth has seen nearly 0.5 degrees of warming in the oceans since 1969; 127 billion tons of ice lost per year in Antarctica since 1993, with the rate of loss tripling in the last decade; and a 30% increase in ocean acidity since before the Industrial Revolution ("Global Climate Change: Evidence," 2020).

The US Climate Extremes Index further confirms that climate change plays an increasingly important role in our daily lives, as extreme weather events have become more frequent in the last several decades ("U.S. Climate Extremes Index (CEI): Graph | Extremes | National Centers for Environmental Information (NCEI)," n.d.).
Figure 8. The US Climate Extremes Index (CEI) from 1910 to 2018. The CEI uses temperature, precipitation, drought, and wind data to summarize extreme weather events each year (“U.S. Climate Extremes Index (CEI): Graph | Extremes | National Centers for Environmental Information (NCEI),” n.d.).

When it comes to the human-caused nature of climate change, the scientific community is unequivocal: researchers conducted a meta-analysis of nearly 4,000 peer-reviewed abstracts from 1991-2011 and found that 97% agreed with the scientific consensus on anthropogenic climate change.

Figure 9. Ninety-seven percent of papers published between 1991 and 2011 agreed with the scientific consensus on anthropogenic climate change (John Cook et al., 2013; Fritz, 2013).
Skeptics may point to alternative causes of climate change. But in an op-ed for the New York Times, the director of the NASA Goddard Institute for Space Studies rebukes them: the ocean might redistribute heat, he says, but it cannot warm independently; volcanoes cool the climate, rather than warming it; if the sun were responsible, the entire atmosphere would be heating up – but instead, the lower portion of the atmosphere warms while the upper part cools (G. Schmidt, 2018).

A visualization with both carbon concentration and temperature shows it best:

![Figure 10](image.png)

**Figure 10.** Data from the Vostok ice core data and Mauna Loa CO2 record provide show the relationship between carbon concentration and temperature. (Bailey, Benton, Challinor, & Elliott, 2015; “Global Climate Change: Evidence,” 2020). Note: This graph shows data up to 2015, but in 2021, the carbon concentration reached 412 parts per million (ppm).

Scientists not only have the data to support the claim that human emissions are causing climate change, but have known the causal mechanism – the greenhouse effect – for over one hundred years. The UN Intergovernmental Panel on Climate Change (IPCC), an internationally recognized body of climate experts, has produced forecast after forecast that accurately predicts future climate:
Figure 11. The IPCC First Assessment Report projection (1990, top), Second Assessment Report (1995, middle), and Third Assessment Report projection (2001, bottom) and real data from multiple sources (Hausfather, 2017). The error bounds exceed a range of 0.6° C, but this uncertainty should inspire more concern – not less.
Scientists have been quite accurate in their projections for up to two decades into the future. Past that, climate change may be milder than we fear – but it may also be substantially worse. The precautionary principle suggests we therefore act now to protect the public from harm (Kriebel et al., 2001).

Experts also offer insights into the impacts of climate change. In addition to the extreme weather events mentioned previously, the UN IPCC projects that 2° C of warming will lead to a species reduction of 18% in insects, 16% in plants, and 8% in vertebrates, and up to a 10% decrease in the amount of global rangeland for livestock (Guldberg et al., n.d.). As a result of these and other challenges, the World Bank projects that in Sub-Saharan Africa, South Asia, and Latin America, nearly 150 million people will be forced to migrate within their countries by 2050 (Rigaud et al., 2018).

Figure 12. Even the US is projected to experience significant internal migration (Goodell, 2018).

Climate change will also act as a “threat multiplier” (Hagel, 2014) for American national security. A 2007 report notes that climate change may make the Arctic more accessible, sparking a conflict with Russia; it may destabilize authoritarian regimes like China and island nations like Indonesia, leading to more
unpredictable foreign affairs; and it may create significant humanitarian disasters in large swaths of Africa and Asia, demanding intervention by the US military (Busby & Council on Foreign Relations., 2007).

Figure 13. Melting sea ice makes the Arctic more accessible and therefore more prone to conflict (van Lohuizen, Kozyrev, & Lamothe, 2018).
Even Exxon – a company that makes billions of dollars from fossil fuels – knew the potential consequences of global warming. See, for example, this 1981 internal memo:
A 2006 statement from the American Association for the Advancement of Science summarizes it best: "The scientific evidence is clear: global climate change caused by human activities is occurring now, and it is a growing threat to society" ("Global Climate Change: Scientific Consensus," 2020).

### 2.2. Media

![Americans remain fairly unperturbed by climate change due to a combination of factors: climate change is a complex problem that’s inherently difficult to grasp, systemic challenges pervade the media ecosystem, and special interests sowed doubt to prevent regulatory action.]

Despite the scientific consensus on and dramatic consequences of climate change, there has been considerable disagreement among the American public as to whether these statements are true. A 2019 survey by Pew showed that while 66% of Americans believe global warming is caused by human activities, only 45% think it will pose a serious threat in their lifetime (Saad, 2019).

Climate change skepticism is complex and multifaceted, but it starts with how humans process information. One challenge, for example, is that the very source of science’s authority may dull its impact: “The process of making things impersonal eliminates not only subjectivity but also meaning… scientific facts arise out of detached observation whereas meaning emerges from embedded experience” (Jasanoff, 2010).

Sheila Jasanoff notes that climate change affronts the human experience at four levels: climate scientists talk “very little about life” and “too much about survival”; they form intergovernmental panels without considering the policy traditions of specific countries (which differ even among liberal democracies); they speak about the Earth as a whole, rather than local spaces with personal value; and they discuss timescales ranging from decades to millennia, while people live their lives day by day and year by year.

Perhaps unsurprisingly, emotion-based “correctives” can help rectify misconceptions (Sangalang, Ophir, & Cappella, 2019). Humor is particularly effective among friendly audiences (Yeo, Anderson, Becker, & Cacciatore, 2020), but for more critical audiences, establishing trust is a key prerequisite for effective climate communication (Goodwin & Dahlstrom, 2014).
These information-processing challenges are compounded by systemic issues at the broadest levels of information consumption. Changing media structures, for example, have led to “stagnating” science news coverage (Schäfer, 2017), and science journalists must increasingly navigate “politicized issues, polarized debates, and interest-driven coverage” (Yeo & McKasy, 2021) to play their roles effectively. Furthermore, pressure from political and industry groups – and abuse of the “fairness doctrine,” which requires broadcasters to present both sides of controversial issues (N. Oreskes & Conway, 2010) – caused the mass media to continue presenting climate change as a scientific debate long after the science was settled. Finally, “news deserts” – “communities with no outlet for locally reported news” – have spread rapidly across the US (Miller, 2018). Given that media coverage offers an important interface between science and the public (National Academies of Science, 2016) – or, as Jasanoff writes, we need “continual interaction… between fact-finding and meaning-making” – news deserts exacerbate the challenge of speaking to local spaces with personal value.

![News Deserts: Counties Without Newspapers](image)

**Figure 16.** In the US, 171 counties do not have a local newspaper, and nearly half of all counties – 1,449 – have only one newspaper, usually a weekly (Abernathy, 2018).

Jasanoff concludes that in order for climate science to be compelling, science’s “impersonal knowledge” must be re-integrated into our personal senses of community, polity, space, and time. At the same, researchers note that journalistic norms like personalization (focusing on humans over systems), dramatization (emphasizing “crisis over continuity”), and novelty (highlighting new over persistent issues) make it difficult to report effectively on broad, systemic problems like climate change (Boykoff & Boykoff,
Ultimately, storytelling and science are two “distinct ways of constructing reality” (Dahlstrom, 2021), and although at their best, they can be integrated to merge “fact-finding and meaning-making,” the tension between science and storytelling can be difficult to manage.

**Figure 17.** Comedy shows like John Oliver’s Last Week Tonight, which hosted Bill Nye to discuss climate change, offer a popular example of combining expertise with narrative.

In addition to structural challenges – and related to establishing trust – climate science has also suffered credibility loss, because fossil fuel companies have undermined public opinion for financial gain. ExxonMobil has been particularly heinous in this regard; even as they contributed to climate research, they waged a concerted effort to sow public doubt. According to one review of ExxonMobil documents from 1977 to 2014, 80% of its internal documents and peer-reviewed publications acknowledged anthropogenic climate change, while 81% of its public advertorials expressed uncertainty (Supran & Oreskes, 2017a). Besides writing public editorials and making public statements, ExxonMobil also funded at least 39 organizations that misrepresented the science on climate change, according to the Royal Society of the UK (Hasemyer & Cushman, 2015). In other words, ExxonMobil has a history of contributing “quietly to climate science and loudly to raising doubts about it” (Supran & Oreskes, 2017b).
InsideClimate News summarizes this trend:

**Figure 18. ExxonMobil has a history of contributing “quietly to climate science and loudly to raising doubts about it”** (Supran & Oreskes, 2017b). Image credit: (Hasemyer & Cushman, 2015).

Interestingly, oil companies used the same methods as tobacco companies who tried to fight regulations on smoking – sometimes even using the same people:

“In case after case, Fred Singer, Fred Seitz, and a handful of other scientists joined forces with think tanks and private corporations to challenge scientific evidence on a host of contemporary issues. In the early years, much of the money for this effort came from the tobacco industry; in later years, it came from foundations, think tanks, and the fossil fuel industry” (N. Oreskes & Conway, 2010).

From 2003 to 2010, Koch Family Foundations and other fossil fuel groups gave 558 million dollars to climate denial organizations, and they only become more secretive in their support since then (Brulle, 2014).
One study found that a complex network of think tanks, corporations, and advocacy groups, promoted scientific misinformation in a way that makes the public see doubt from “diverse” sources” (Farrell, McConnell, & Brulle, 2019).

Figure 19. Robert Brulle illustrates a complex network of funders (diamonds) and recipients (circles) in the “climate change counter-movement” (Brulle, 2014). Notable funders include Donors Trust, Koch Affiliated Foundations, and the American Petroleum Institute; notable recipients include the American Enterprise Institute, Heritage Foundation, and Heartland Institute.

Although historically, the industry groups most active in climate debates worked largely to prevent regulations, this decade’s increasingly harmful climate events have spurred more Earth-friendly responses, as well. Twenty-one percent of the world’s largest public companies, including Ford and American Airlines, have committed to reducing their carbon emissions to zero (Black et al., 2021), and Microsoft has pledged to become carbon negative by 2030 (Smith, 2020). Furthermore, many large companies, including Walmart, BP, and Shell, lobbied the Trump administration (unsuccessfully) to stay in the Paris Climate Accords (Center for Climate and Energy Solutions, 2017). Even Wall Street has become more active: Blackrock, the world’s largest asset manager, has forced companies to assess climate risk (Fink, 2021), because, as their CEO writes, “Climate risk is investment risk.” The political and financial benefits of these developments
are important in their own right, but these moves also promote media coverage that makes the climate crisis more salient in the minds of viewers (Cialdini, 2018). Nonetheless, climate skepticism remains potent in the race against climate change. This phenomenon cannot be understood without a discussion of politics.

2.3. Politics

Special interest groups funded politicians who were already opposed to government interventions — conservatives — which further polarized and muddied the issue in the eyes of the public. Moreover, even climate-friendly politicians have been largely unable to enact reforms that would help keep Earth below two degrees of warming.

As ExxonMobil and others preached the gospel of scientific uncertainty for financial reasons, it found an ally in those who opposed government regulation for ideological reasons — namely, conservatives and Republicans. With the 1989 creation of the Global Climate Coalition (GCC) — “a lobbying partnership of leading oil and automobile companies dedicated to defeating controls on carbon pollution” (Hasemyer & Cushman, 2015) — ExxonMobil made inroads with Republican politicians. The GCC shut down in 2001, but in the last twenty years of oil and gas lobbying, ExxonMobil has never dropped out of the top three biggest donors, and it was number one for fifteen of those twenty years (OpenSecrets.org, 2019).

The oil and gas lobby has filled Republican coffers with millions of dollars:

![Figure 20. In 2000, 78% of oil and gas contributions went to the GOP. Since 2012 that number has been closer to 90% (OpenSecrets.org, 2019).](chart)

Dems  Repubs
Furthermore, the fossil fuel industry outspent environmental organizations and the renewable energy sector by a ratio of 10:1 in congressional lobbying from 2000 to 2016 (Brulle, 2018). Perhaps this dynamic is best captured by a cartoon that appeared in the Boston Globe:

![Figure 21. Dan Wasserman’s editorial cartoon in the Boston Globe captures the relationship between Republicans and fossil fuel companies (Wasserman, 2014).](image)

The partnership between conservative politicians and fossil fuel companies has led to a stark divide in climate perceptions between Republicans and Democrats (Funk, Kennedy, Hefferon, Strauss, & Caiazza, 2018).
Political scientists Aaron McCright and Riley Dunlap point to two factors in this extreme partisanship. First, they cite elite cues hypothesis: in cases with conflicting information, people rely on trusted partisan leaders – which mean different elites, different media sources, and different institutions for different people (McCright & Dunlap, 2011). The lack of a unifying authority figure – like the Surgeon General in the case of the tobacco controversy, for example – left a gap that climate skeptics could cram into (Naomi Oreskes, 2012).

McCright and Dunlap also cite information-processing theory: people filter information through their values, ideologies, and experiences (McCright & Dunlap, 2011). Information-processing theory relates more broadly to the idea of identity, “our sense of who we are in the world” (Stone, Patton, & Heen, 2010). People’s identities stem from group identifications, which can be based on gender, religion, race, nationality, class, family, or other categories (Appiah, 2018). Each identity acts as a feedback control system, modifying our behavior to fall within some standard set by that group (Stets & Burke, 2014), e.g. “A good American should do X and not Y.” By “miniaturizing” people – that is, by treating people as one-dimensional, rather than containing a rich, complex set of identities – political leaders can emphasize one such standard over the rest, stirring resentment, resistance, and even violence (Sen, 2007). This miniaturization process can
also occur via trauma, which cements a particular identity in a dominant position (R. Heifetz et al., 2009) – as when aggrieved white people unite around whiteness to protest changes they see as threatening (Jardina, 2019). No surprise, then, that people with strong predispositions towards free markets and national sovereignty – that is, people with conservative identities – are biased against climate science and related interventions (Drummond & Fischhoff, 2017). For this group, acknowledging the reality of climate change “poses a fundamental critique of our current industrial capitalist economic system” (McCright, 2011) – a severe departure from their identity standards for belonging to conservatives, Americans, or other groups.

This bias is so firmly entrenched, even scientific literacy cannot overcome it. Rather, scientific literacy leads to increased polarization: among more scientifically literate citizens, there exists a wider partisan gap, as they are better able to find evidence and support positions that align with their values (Kahan et al., 2012).

![Figure 23. Hierarchical individualists – those who eschew community intervention in individual affairs – and egalitarian communitarians – those who favour community attention on individual needs – only diverge further with respect to climate risks as they become more scientifically literate and numerate (Kahan et al., 2012).](image)

Neither political movements nor legitimate media have been particularly effective at promoting change. Anthony Leiserowitz, the director of the Yale Program on Climate Change Communication, notes that in terms of political activism, today’s climate movement has several weaknesses: it remains “relatively small
and disorganized,” not having been molded into a politically muscular coalition; it has not built “silent permission” for action among less engaged members of the public; and it has not cultivated a diverse representation, with most Americans viewing climate activism as the domain of scientists, environmentalists, and liberal politicians (Leiserowitz, 2019).

It’s easy to see why climate change skepticism remains common in the US. Financially-motivated oil and gas companies funded ideologically-motivated conservatives to deny science for several decades. Together, they cowed the media into presenting both sides of the climate debate as legitimate. The public then processed an already complex and unrelatable issue through identity-driven, selective filters.

As a result, even when environmentally-friendly politicians have been in power, they’ve not been able to make the difficult changes needed to curb emissions – or their efforts have been easily undone by their successors. President George H.W. Bush, for example, strengthened the Clean Air Act (Waldman, 2018) – now a key tool in the fight against climate change (Union of Concerned Scientists, 2012) – and signed into law the Global Change Research Act of 1990, requiring a National Climate Assessment to be researched and released every four years (Waldman, 2018). President Bill Clinton then committed the US “to reducing our emissions of greenhouse gases to their 1990 levels by the year 2000” (Berke, 1993). But emissions rose steadily throughout the 90s (US EPA, 2021).


**Figure 24.** US carbon emissions rose steadily through the nineties before beginning a decline in 2007 (US EPA, 2021).
When President George W. Bush took office, he reversed course on many of Clinton’s climate actions, most prominently by refusing to implement the Kyoto Protocol (Borger, 2001), which would have required the US to cut emissions, as well as by pressuring government scientists to tailor their findings to the administration’s climate skepticism (Grifo, 2007).

As for President Obama, he negotiated the Paris Climate Accords (Lavelle, 2016) – a milestone in international climate agreements – and helped lower emissions through executive actions (Bookbinder, 2017). But the Paris Accords are non-binding, and even if they were binding, they would not keep Earth below the 2-degree warming threshold suggested by the IPCC (Paris Agreement turning point, 2020).

Figure 25. Current policies would likely lead to around 2.9 degrees of warming, while meeting Paris Agreement pledges and targets would lead to 2.6 degrees (Paris Agreement turning point, 2020).
Furthermore, because Obama relied on executive action to address climate change – legislating climate policy with a Republican-held Senate may have been impossible – President Trump was able to impair environmental progress substantially during his term. He rolled back over 100 environmental regulations and pulled the US out of the Paris Climate Accords, damaging America’s credibility on environmental issues (Davenport, 2020). Today, climate change has become increasingly salient, and President Biden frames it through a jobs creation lens (“Biden’s Speech to Congress: Full Transcript,” 2021) – so perhaps the current administration will manage to generate long-lasting change on America’s climate stance.

Although mustering the effort needed for climate action may feel like an impossible task, it’s worth noting that other countries have begun this undertaking in earnest. The 2020 climate change performance index (CCPI), which evaluates fifty-seven countries based on greenhouse gas emissions, renewable energy, energy use, and climate policy, shows that India, Morocco, Chile, and a large swathe of European countries outperform the rest of the world in terms of climate change performance. Saudi Arabia and America occupy the bottom two slots (Climate Change Performance Index, 2020).

![Climate Change Performance Index](image)

**Figure 26.** The Climate Change Performance Index assesses countries based on GHG emissions, renewable energy, energy use, and climate policy (Climate Change Performance Index, 2020).

Perhaps this is not surprising; according to a survey of European attitudes on climate change, the number of people in European countries who agreed with the statement, “Climate change is happening,” ranges from 82.2% in Russia to 97.7% in Iceland, with Italy as the median at 94.8%. (European Attitudes to Climate Change and Energy, 2018). In the US, only 72% of people agreed (Howe, Mildenberger, Marlon, &
Leiserowitz, 2015b). Furthermore, Europe’s Green Party has gone from holding 4.8% of the seats in the European Parliament in 2004 to 11.4% in 2019 (Pop & Bender, 2019). Here, it’s worth noting an additional factor that likely contributes to American hesitance on climate action: Americans have an extremely high per capita carbon footprint, so emissions reductions entail a comparatively high loss for the US.

**Figure 27.** *Americans have an extremely high per capita carbon footprint (Bewicke, 2019).*

Ultimately, forty nations, including many in Europe, have implemented carbon pricing policies to disincetivize emissions, but the US has not yet done so (“Pricing Carbon,” 2020). Even now, after Project Drawdown created a blueprint to solve climate change (Hawken, 2017), it’s far from certain that America will take action in time to prevent catastrophic impacts.

### 2.4. Conclusion

This chapter summarized climate change from the perspectives of science, media, and politics. Scientists have accumulated decades of evidence for anthropogenic climate change and its harmful consequences, including natural disasters, climate migration, and conflict. Nonetheless, Americans remain fairly
unperturbed by climate change, as the issue has become polarized – partially due to its sheer complexity, and partially due to systemic challenges related to media consumption and political funding. Identity underpins many of these factors, which have complicated American leaders’ attempts at solving the climate crisis. In the next chapter, I offer perspectives on three disciplines that inform how climate change can be addressed: community organizing, climate education, and leadership.
3. Background on community organizing for climate education

Environmental organizations have existed for decades, but in today’s context, Anthony Leiserowitz offers insights into building “public and political will for climate action” (Leiserowitz, 2019). He notes, for example, that citizen action remains relatively small and disorganized: only four million people are involved with campaigns to sway elected officials, even though an additional thirty-five million – roughly one in ten Americans – say they would “definitely” or “probably” join such campaigns. Furthermore, Leiserowitz notes that the opposition to climate action is far better coordinated than the climate movement, and therefore better able to influence policy. He also points out that the “alarmed” segment of the American public primarily represents scientists, environmentalists, and liberals – unfamiliar “others” to most Americans – making climate change “their” issue, rather than “my” issue. “Most Americans have not yet seen people like themselves demanding climate change action,” writes Leiserowitz. Climate activists must not only diversify the alarmed segment, but also build a “silent permission for action” among the middle 70% of Americans, who are neither alarmed by nor dismissive of climate change; this middle may never become vocal, but elected officials rely on their permission nonetheless. Finally, Leiserowitz notes that relatively few environmental or climate groups develop citizen activists as leaders. Climate change offers community organizers abundant opportunities to strengthen the movement, which has room for growth in terms of coordination, representation, and power.

This chapter reviews literature on community organizing, climate education, and leadership. In particular, organizers turn communities with shared interests into constituencies with the power to create change. They do this by building relationships, telling stories, creating structure, devising strategy, and taking action. Furthermore, climate education is an overlooked, but key opportunity to address climate change. The education sector, however, is not yet ready to teach about climate change. Researchers have developed recommendations both for institution-level reform and for curriculum-level reform. Finally, leadership is love. To be effective, leaders need negotiation, communication, and storytelling skills. Communication means getting messages across, not just information. Negotiation means balancing assertiveness and empathy. Storytelling means sharing key moments of pain and hope that connect with listeners. Self-awareness, both external and internal, underpins these practices.
3.1. Community organizing

Community organizing is about people, power, and change. More specifically, it’s defined by Marshall Ganz, who led Barack Obama’s 2008 organizing campaign, as “leadership that enables people to turn the resources they have into the power they need to make the change they want” (Ganz, 2014).

First, people. In community organizing, building relationships is an end in its own right, not just a means (Christens, 2010). But organizing is not only about building relationships, it’s also about building capacity: a leader’s most important responsibility is developing other leaders (Khan, 1992). Rather than focusing on issues, organizers focus on people; they aim to turn communities – “people who share common values or interests” – into constituencies – “people standing together to realize a common purpose” (Ganz, 2014). Effective communities are therefore both small and grounding, as well as large and broadening, with strong democratic practices to help manage the tension (R. Fisher & DeFilippis, 2015); the organization’s size and structure should be sufficient to achieve the goal, while ensuring people feel a sense of belonging and participation (Khan, 1992).

Hahrie Han finds that the most successful community organizations are those that combine “transformational organizing” – developing members’ capacity for leadership – with “transactional mobilizing” – maximizing the number of participants (Han, 2014). Han challenges the assumption that breadth and depth oppose each other. Rather, she finds that the best organizations invest in their members (depth) to build their capacity to grow membership (breadth). Ganz qualifies this idea, noting that organizations must develop leadership capacity everywhere – not only at the top – because peer-peer relationships are just as important as peer-leader relationships. “The challenge,” he writes, “is to cast a net widely enough to recruit others to do this work, create the capacity to train them, and offer the coaching to support their development” (Ganz, Nohria, & Khurana, 2010).

Next, power. Power is the probability that an individual or a group will have its will win out despite the resistance of others (Wallimann, Tatsis, & Zito, 1977), and it is central to community organizing (Alinsky,
1989; Beckwith, 2019; Ganz et al., 2010; Han, 2014; Khan, 1992; Minkler, 2012; Schutz & Sandy, 2011).

As Saul Alinsky writes – Alinsky is known as the “father” of community organizing for being the first to codify its practice – community organizing “creates durable institutions and builds local leadership, giving otherwise fractured communities a unified voice and the collective power necessary to resist oppression” (Schutz & Sandy, 2011). Increasing power can mean increasing how many people the organization can mobilize, how many leaders it has, how much money it has, or something else (Section 3.3.2 on negotiation offers a deeper discussion of power). Ideally, the organization develops such a strong reputation that it is consulted on important decisions before they are made (Schutz & Sandy, 2011). In any case, organizers cannot limit their focus to a single battle; rather, they must constantly work “to enhance their capacities for winning even more in the future” (Schutz & Sandy, 2011).

Finally, change. Organizers believe that “significant social change only comes through conflict with the entrenched interests of the status quo,” and that long-term accountability is crucial to maintaining gains (Schutz & Sandy, 2011). Alinsky cites, for example, FDR’s response to a reform delegation: "Okay, you’ve convinced me. Now go on out and bring pressure on me!” (Alinsky, 1989). He further notes that revolutionary change requires people to feel frustrated, defeated, and so “futureless” that – even if they don’t know what to do, and even if they themselves won’t act – they won’t stop those that do (Alinsky, 1989). This idea, related to “productive disequilibrium” (R. Heifetz et al., 2009), is explored more deeply in Section 3.3, Leadership. Overall, people, power, and change are coupled quite tightly: the organization’s strategy for change should be rooted in its culture, building on the experiences of its people, and it should allow people to learn more about themselves, the organization, and power (Khan, 1992).

In addition to people, power, and change, community organizers also share the values of realism and irreverence. Realism, for example, means recognizing that organizing takes time; instant, dramatic change is rare. Alinsky writes, “It is tedious, but that’s the way the game is played – if you want to play and not just yell, ‘Kill the umpire’” (Alinsky, 1989). Furthermore, Alinsky cautions that organizers must work with the world as it is, not as they think it should be. That means working inside the system – or, as Alinsky puts it, “What is the alternative to working ‘inside’ the system? A mess of rhetorical garbage about ‘Burn the system down!’” (Alinsky, 1989). Organizers must therefore reach across existing political, cultural, religious, and other divides (Schutz & Sandy, 2011), and they must work with already-established, though
imperfect, institutions, like schools, churches, and unions (Bobo, Kendall, & Max, 2001). Realism also means maintaining a practical scope of operations. Organizers therefore “cut issues out of problems,” such as constraining “world hunger” to “reallocating a city budget to increase food pantry resources” (Schutz & Sandy, 2011). Similarly, organizers focus not on who caused a problem, but on “who can be legitimately made responsible for it” (Schutz & Sandy, 2011). Community organizing “is about self-interest, not about charity” (Beckwith, 2019), so realism must permeate community organizing at every level of decision-making.

Fortunately, the need for realism is balanced by an appreciation of irreverence (Alinsky, 1989). Some organizing teachers remind readers that “Our organizing framework is just that, a framework, not a formula” (Ganz, 2014), while others write explicitly, “We recommend that you don’t take what we say too seriously” (Schutz & Sandy, 2011). Perhaps this irreverence is necessary to stay alive in organizing: after all, “We are usually taught that truth matters and will win out, but we are not taught that truth alone is rarely enough to produce significant change – it’s not in the interests of powerful people to teach the less powerful how to resist them” (Schutz & Sandy, 2011). It makes sense that organizers can’t take things too seriously; often things are serious only because people in power decided they should be. Ultimately, organizing is an adaptive challenge (R. A. Heifetz & Linsky, 2017), which requires experimentation and playfulness (Section 3.3. covers adaptive leadership more thoroughly). As is typical in adaptive settings: “We don’t know what to do to solve your problem. It’s your problem. You need to figure it out” (Schutz & Sandy, 2011).

Perhaps the intersection of realism and irreverence is best illustrated by example: in an organizing workshop, one student, intending to pressure a problematic radio host, suggested bringing people to the host’s biggest advertiser, a car dealership, and having them test-drive cars without buying them, tying up staff for hours (Schutz & Sandy, 2011). This example never played out, but it illustrates both the creativity and the pragmatism involved in effective organizing.

With respect to education and climate change, community organizing is of particular interest, because in the past, organizers have successfully pushed for educational reforms like opening community learning centers, improving teacher pay, and redesigning low-performing schools (Warren, 2020). Furthermore, because climate change can feel overwhelming and isolating, community organizing can help unite people
in pushing for change (Divakran & Nerbonne, 2017). In a large ecosystem of social change strategies – legal action, activism, political campaigning, advocacy, community development, and direct service, for example (Schutz & Sandy, 2011) – community organizing plays an important role in generating the pressure needed for change.

In his Organizer’s Handbook, Ganz codifies best organizing practices based not only on his own five decades of experience, but also on the combined experiences of the Leading Change Network and New Organizing Institute – that is, on the combined experiences of millions of other organizers. Ganz breaks organizing into five key practices: building relationships, telling stories, creating structure, devising strategy, and taking action (Ganz, 2014). These practices provided a clear initial framework for EarthDNA Ambassadors, although as noted above, the organization will likely depart from the framework as it learns what works and what doesn’t.

Figure 28. Community organizing is values-based, constituency-focused leadership that turn resources into goals via shared story, shared commitment, shared structure, shared strategy, and shared action (Ganz, 2014).
3.1.1. Building relationships

Ganz writes that one-on-one meetings are a powerful tool for building relationships. Organizers use these meetings to recruit new members, maintain current members, and escalate members into new leadership roles. Ganz notes that because organizers should have one-on-one meetings at least twice per month with each member of their team, this limits team size to around five people.

Ganz also stresses the importance of hard asks: “an ask that results in a commitment to a specific action,” as opposed to vague asks like, “Would you maybe want to join our group soon?” He also explains that there are three types of no: “Not now,” “Not that,” and “Not ever.” In both recruitment and escalation – giving a community member more responsibility – knowing the difference is key.

A few other best practices include following up with people within 48 hours, always scheduling for the next event, and planning for 50% attendance. Finally, Ganz notes the following top reasons for why volunteers don’t return: they don’t feel it’s worth their time, the atmosphere is disorganized, and they feel overwhelmed or unimportant. Power in organizations stems from members’ commitment to one another, and strong relationships underpin this commitment.

3.1.2. Telling stories

People tell stories to communicate values and inspire emotion. Organizers, for example, combine a story of self, a story of us, and a story of now – using shared values as a common thread – to motivate action. First, they tell a story of self to connect themselves to their audience; they answer, “Why me?” by sharing a challenge, choice, and outcome that illustrates the value that drives them to act. Next, organizers use a story of us to connect their audience to each other; they answer, “Why us?” by sharing a collective challenge, collective choice, and collective outcome that illustrates how their value is a value shared by everyone. Finally, they use a story of now to connect everyone to the present moment; they answer “Why now?” by highlighting a challenge to the shared value, the choice the organization has before it, and the beautiful outcome if they make the right choice.

This structure – story of self, us, and now – not only applies in speeches, but also in one-on-one settings.
Stories, Ganz writes, overcome action inhibitors (inertia, apathy, fear, isolation, self-doubt) by mobilizing action motivators (urgency, anger, hope, solidarity, and you-can-make-a-difference). In other words, stories are a crucial part of the organizer’s toolkit.

Effective teams offer more support and more resources than independent actors, so teams are critical in organizing. Ganz writes that teams require shared purpose, interdependent roles, and explicit norms. He advocates for a snowflake model, also known as “distributed leadership,” which decentralizes decision-making whenever possible: each member of a core leadership team has their own team, and each member
of those teams has their own team, and so on, building outward like a snowflake. This structure allows for mutual accountability, clearly defined roles, and exponential growth. Both members and teams evolve over time – members, from “supporter” to “organizer,” and teams, from “potential team” to “developed team” – and if done correctly, the snowflake model can support long-term growth in both depth and breadth.

![Snowflake Model Diagram]

**Figure 31.** The snowflake model decentralizes decision-making, allowing each team to operate independently while maintaining a connection to the organization as a whole (Ganz, 2014).

### 3.1.4. Devising strategy

Ganz defines strategy as “turning what you have into what you need to get what you want.” In other words, strategists identify their people, their problem, and their goal. People include leaders, supporters, competitors, and opposition. Problems have a past – why hasn’t it been solved? – and a future – what would it take to solve it? Goals are clear, measurable, and replicable; they focus resources, build the organization’s capacity and target a point of leverage; and goals focus on an issue that motivates the constituency.

Effective strategizing yields a theory of change: “If we do ___, then ___, because ____.” For example: “If we inspire young people to talk to their parents about the climate crisis, then we can pressure elected officials into passing effective climate policies, because those parents comprise a key part of the elected officials’ constituencies.” Ultimately, strategy is fractal. There must be a broad organizational goal, a “mountain top goal,” but there are also sub-goals that each require their own theory of change to achieve.
3.1.5. **Taking action**

When it comes to taking action, Ganz writes, “Strategy without tactics is just a bunch of nice ideas. Tactics without strategy are a waste of resources.” Implementing tactics – that is, taking action – requires two components: commitment and motivational engagement. First, organizers seek commitment from their members to achieve specific, measurable outcomes. Second, organizers design actions that offer impact, autonomy, and growth. These two ideas support “organizing sentences,” thesis statements for each team in the organization: “We are organizing (our people) to (strategic goal) through (tactics) by (timeline).”

To make progress, organizers embark on campaigns. They start with foundation-building, which creates the capacity needed to launch a campaign. Next, they kick the campaign off with a rally-type event, which offers an opportunity for recruitment, creates urgency around the campaign, and forces the formal allocation of roles for managing the campaign. The campaign then proceeds in peaks, attempting goal after goal and building capacity, until the moment of maximum mobilization, which offers the organization its best shot at achieving its overall goal. Afterwards, the organization evaluates the outcomes, celebrates its achievements, and looks towards the future.

**Figure 32.** Organizers embark on campaigns, reaching peak after peak and building capacity until they reach their mountaintop goal (Ganz, 2014).
Needless to say, community organizing is difficult. Saul Alinsky makes this clear in *Rules for Radicals*, listing the qualities an organizer needs: curiosity, irreverence, imagination, a sense of humor, “a bit of a blurred vision of a better world,” an organized personality, “a well-integrated political schizoid,” ego, and a free and open mind (Alinsky, 1989). It’s a long list – but community organizers have played, and will continue to play, a crucial role in the challenge of overcoming climate change.

### 3.2. Climate education

*Climate education is an overlooked, but key opportunity to address climate change, as young people make ideal messengers. Unfortunately, the education sector is not yet ready to teach about climate change. Researchers have developed recommendations both for institution-level reform and for curriculum-level reform.*

In 1992, the UN Framework Convention on Climate Change resolved to “Promote and cooperate in education, training and public awareness related to climate change and encourage the widest participation in this process, including that of non-governmental organizations” (Reid, 2019). Partially due to expanded funding, and partially due to the increased salience of climate change, interest in climate education has indeed increased over the last few decades: there were over 1,400 published research articles on the topic between 2010 and 2015, as compared to 12 publications between 1990 and 1999 (Monroe, Plate, Oخارارت, Bowers, & Chaves, 2019). But according to researcher Allison Anderson, the education sector remains an “untapped opportunity to combat climate change” (Anderson, 2012). A study of 78 countries found that only 36% referenced climate change in their national curriculum frameworks (Kwauk, 2020). And in the US, researchers found that 85% of science teachers teach climate change, but 30% of them teach “both sides” of the “controversy” (Plutzer et al., 2016).
Figure 33. Although 85% of science teachers teach climate change, nearly a third of them teach “both sides” of the “controversy” (Plutzer et al., 2016).

They also found that science teachers are alarmingly ill-equipped to teach the subject: “Less than half of all science teachers are aware that more than 80% of climate scientists think that global warming is caused primarily by human activities” (Branch, Rosenau, & Berbeco, 2016). More broadly, across teachers of all subjects, 58% do not teach climate change at all, citing the dominant factor as, “It’s not related to the subject(s) I teach” (Kamenetz, 2019). Climate change education, when delivered, usually takes place through the lens of science and technology, leaving questions about consumerism, ethics, and values largely “rhetorical” (Lehtonen, Salonen, & Cantell, 2019).

Figure 34. The most common reason teachers don’t teach climate change is, “It’s not related to the subject(s) I teach” (Kamenetz, 2019).
In place of formal education, other groups have played a role in filling the gap. Museums, science festivals, and other science-based media provide informal education, and because they are “internally rather than externally driven,” learning is often long-lasting (Stocklmayer, Rennie, & Gilbert, 2010). Similarly, members of USDA’s youth development group, 4-H, are twice as likely to participate in science programs outside of school and twice as likely to be civically active (Lerner & Lerner, 2013). Meanwhile, NGOs like the Alliance for Climate Education, CARE, and Education International have created resources for schools and teachers, and campaigns like the Climate Action Project, Schools for Climate Action, and the Sunrise Movement have helped connect various groups and efforts (Kwauk, 2020). But these initiatives are often “isolated,” with researchers concluding they have been “either at a scale too small to change the system meaningfully, or at a large enough scale but through action too low-impact to make a difference.” The Climate Reality Project, meanwhile, has trained over 30,000 members who teach workshops on climate change, but they do not focus on educating young people (Climate Reality Project, 2021).

This gap in climate education is unfortunate, as adolescence offers a window of opportunity: adolescents can understand complex subjects like climate change, but their beliefs about the world are still plastic (Lawson et al., 2019), so identity plays less of a role in mediating climate change beliefs (Stevenson, Peterson, Bondell, Moore, & Carrier, 2014). Nonetheless, a study by the Alliance for Climate Education (ACE) found that 13- to 17-year-olds are actually worse at climate science than adults (Flora et al., 2014). ACE therefore offers “an entertaining, multi-sensory, engaging school assembly available free of charge to schools across the U.S.” According to pre- and post-presentation surveys, ACE improves climate literacy and behavior (particularly for increasing climate discussion with parents), and they have reached millions of students around the US. Still, authors conclude that “a one-time event is unlikely to produce lasting change,” and that post-presentation activities are necessary for sustained impact.

### 3.2.1. Obstacles to improving climate literacy

Many obstacles impede the progress of climate literacy. Most broadly, write Corner and Groves, society lacks the necessary institutions to allow scientists to engage with the public in a way that retains their scientific credibility, but is also effective in shaping public opinions (Corner & Groves, 2014). They argue that climate research is inherently political – “Its description of the world contains an implicit judgement on the question of how we should live” – and that citizens do not change their minds for the same reason
as scientists. Citizens are likely to be biased by the culture and values represented by the communicator of a message – the messenger, in fact, matters more than the message. Another study confirms this problem, noting that even the most scientifically literate individuals seek out “ideologically compatible information and interpret new information in ways that support their pre-existing views” (Stevenson et al., 2014). This even extends to science teachers, as those with more Republican peers tend to be more unaware of the consensus on climate change (Branch et al., 2016).

Within the education sector, the Brookings Institute identifies five major roadblocks that prevent robust climate education at a wide scale (Kwauk, 2020):

1. Eco-literacy is low on the to-do list when basic literacy is still an unmet global goal;
2. The global education community lacks a radical vision for education, aiming instead to serve corporate needs;
3. Current education is more about sustainable development than for it, offering students information about the environment without giving them tools, such as systems thinking, that can help them be more sustainable;
4. Monitoring and accountability mechanisms are oriented toward passive progress; and,
5. Teachers lack the systemic support to become change agents for sustainability.

Climate education also inherits challenges from science education in general. For example, the classes where climate change fits most neatly – environmental sciences, for example – are “comparatively neglected” relative to physics, chemistry, and biology (Branch et al., 2016). Science teachers also vary widely on whether their role is simply to convey facts or to facilitate difficult discussions (Monroe et al., 2019). Meanwhile, educators face the challenge of welcoming diverse viewpoints, while “dispelling students’ misconceptions about climate science, which are often heavily supported by socio-cultural factors” (Monroe et al., 2019). Furthermore, science education is plagued with a terribly difficult question that “trickles down” to climate education as well: “How can school science education both prepare some students to go on to careers in science and technology and prepare all students to be responsible, scientifically literate, citizens?” (Stocklmayer et al., 2010). Finally, science education often runs into political barriers: although seventeen states have adopted education standards that include climate change – a sign of progress – Iowa, Michigan, and Wyoming state legislatures have all introduced bills to prevent their adoption (Branch et al., 2016).
Of course, climate change is incredibly complex, spanning not only the natural sciences, but also history, economics, political science, and many other fields. These disciplines are typically taught separately from one another, which means teaching climate change would require teachers to learn new methods and explore new areas (Schreiner, Henriksen, & Kirkeby Hansen, 2005). Furthermore, Western education promotes rational minds, but shortchanges emotional and somatic development (Lehtonen et al., 2019). This is unfortunate, because “the experience of our existence... is located in our body” and therefore “information becomes alive and meaningful, if we experience it with our bodies” (Snaza et al., 2014). Our education system may be unprepared to handle “true” climate education, which would include the emotionally and physically intense reevaluation of value hierarchies (Selby, 2010).

Thus, while positive examples of radical educational reforms abound within individual schools and programs – see, for example, XQ Institute Super Schools, the Khan Lab School, and Summit Public Schools – the education sector as a whole remains largely mired in challenges. Perhaps the difficulties with systemic education reform are best summarized in the passage below (Stocklmayer et al., 2010):

Kahle (2007) examined three waves of large-scale attempts to radically revise the whole system of science curriculum in the USA, charting their progress from their inception to their final outcomes. Her analysis confirmed that the current challenges to improving school science are immense: not only does change take considerable time, and requires both top-down and bottom-up approaches, but it must be supported by the politics of the day. Further, ways have to be found to make new curricula available to all students. This has to take place against a background of gender issues, of ‘border crossing’ arising from the increasingly diverse cultural backgrounds in many student populations (Aikenhead, 2006) and the very diverse economic circumstances of schools, students and their families (Berliner, 2009).

3.2.2. Recommendations for improving climate literacy

Researchers have developed recommendations both for institution-level reform and for curriculum-level reform. On an institutional level, the Brookings Institute recommends filling knowledge gaps at scale, especially since education offers an existing, multi-tiered system where solutions can be scaled and
transferred from a classroom to a school district and beyond (Kwauk, 2020). They also suggest creating 50-year, localized plans for education that explore different possibilities for life in a changing world. Finally, they advocate for cross-sectoral coalitions: education should become a space where energy, gender, finance, labor, and other fields come together to “multi-solve.” This process can be further bolstered by “greater synergy” between the formal and informal education sectors, where top-down communication turns into mutually respectful dialogue (Stocklmayer et al., 2010). Given that “children can foster climate change concern among their parents” (Lawson et al., 2019), the cultural change from these educational reforms could “trickle up” to older, hard-to-reach generations as well. These initiatives could help facilitate exchange between climate science and the public at large (Corner & Groves, 2014).

In terms of actually teaching climate change, researchers have developed a long list of important concepts. One common theme is the interdisciplinarity of climate change (Anderson, 2012; Plutzer et al., 2016). Children should learn about climate change in all classes: not only in science, but also in civics and geography, for example (Anderson, 2012). Across these disciplines, students should explore three key concepts: “action at an attentional distance” – cause and effect in complex systems can exist quite far apart in time and space, e.g. American emissions from the 1920s are contributing to climate impacts in India today; “distributed causality” – many separate causes can collectively lead to surprising outcomes, e.g. many people generating tiny (individual) carbon footprints can emit enough greenhouse gas to change our planetary system; and “probabilistic causality” – a cause does not have to lead to an effect with one-hundred percent certainty for them to be related, e.g. not every wildfire is related to climate change, but climate change nonetheless makes many wildfires worse (Shafer, 2015). Of course, if learning can be tied to hands-on, local activities, it’s even more effective: “Climate change educational interventions are most successful when they focus on local, tangible, and actionable aspects of climate change” (Anderson, 2012; Monroe et al., 2019). For example, schools in coastal areas might have students do experiments with ice melting in water to model the impact of melting ice on sea-level rise. Lastly, researchers note that content creators should not, at the moment, assume that teachers have mastered concepts underlying climate change; future teachers need more preparation in order to teach climate effectively (Plutzer et al., 2016).

Of course, many strategies for engaging the public also apply to engaging with students. Educators should use narrative techniques, visual imagery, and persuasive texts (Anderson, 2012); they should tell human-centered stories that connect with the values of their audience (Corner & Groves, 2014); and they should
share viewpoints from “culturally congruent conduits” that make climate messaging more palatable (Corner & Groves, 2014). Teachers can also consider “inoculating” their students against climate misinformation: showing them flawed arguments and untrustworthy institutions, and explaining why they’re flawed, before students hear these arguments earnestly (Farrell et al., 2019). Finally, teachers should be positive and concrete, focusing on solutions, values, and empowerment (Anderson, 2012). If successful, educators can catalyze a virtuous cycle where students talk about climate change, become more likely to learn about it, talk about it even more, and so on (Goldberg, van der Linden, Maibach, & Leiserowitz, 2019).

Ultimately, climate education can be “seized to think about what really and profoundly matters, to collectively envision a better future, and then to become practical visionaries in realizing that future” (F. Kagawa, 2010). This requires that the “whole spectrum of emotions” be given space for expression, including, for example, through art and dance (Lehtonen et al., 2019). Furthermore, climate education should break false dualities like “nature vs. culture” and “emotion vs. ration,” allowing learners to understand “the interconnectedness of planetary elements” (Lehtonen et al., 2019). Put simply, the goal of climate education should be “to fully realize our humanity” (Lehtonen et al., 2019).

Figure 35. Effective climate change education should break false dichotomies and instead reveal interconnectedness (Lehtonen et al., 2019).
3.3. Leadership

“Leadership” seems to have as many definitions as people trying to define it. Marshall Ganz says leadership is “taking responsibility for creating shared purpose in the face of uncertainty” (Ganz, 2014); Robert Greenleaf created servant leadership (Greenleaf, 2002), emphasizing the desire to serve others; Barbara Kellerman notes that leadership is a system that includes, in addition to leaders, followers and contexts (Kellerman, 2016); and for Warren Bennis, “Becoming a leader is synonymous with becoming yourself” (Bennis, 2009). In the context of climate change, Ronald Heifetz’s definition is particularly useful: Heifetz, Grashow, and Linsky define adaptive leadership as “the activity of mobilizing people to address difficult realities they’d rather avoid” (R. Heifetz et al., 2009). The following section summarizes concepts from their book, The Practice of Adaptive Leadership:

The world is always changing. Some groups adapt; others die. In some cases, technical work can address the challenge: organizations can solve the problem with time, money, and expertise – for example, they can create committees, update policies, or hire consultants. In many cases, however, adaptive work is required: time, money, and expertise are insufficient, because the real obstacles are people’s values, loyalties, assumptions, and practices. Adaptive challenges often implicate the core of an organization, forcing people to ask, “Who are we, really?” In these cases, the people with the problem are the problem – and the solution.

Most challenges have both technical and adaptive components. It can be useful to frame challenges as gaps between the organization’s aspirations and the organization’s reality – noting, of course, that not everyone will agree the gap exists or that it’s important – and then to distinguish between adaptive and technical components of the challenge. For someone suffering from heart problems, for example, technical work may include medical check-ups or surgery, while adaptive work may involve changing their diet and lifestyle. In organizations, gaps between aspirations and reality can occur at the level of values, purpose, objectives, strategy, or tasks.
Adaptive work is difficult, as people resist loss – e.g. loss of comfort, loss of power, loss of the past. The only time people are willing to engage with potential loss is when they’re experiencing discomfort. Part of exercising adaptive leadership is therefore to maintain an appropriate level of discomfort, or “productive disequilibrium”: too low, and there’s not enough pressure to change; too high, and the pressure makes it impossible to reflect and learn. A person having a heart attack is probably not receptive to diet suggestions, but a person who’s completely comfortable is also unlikely to change. Either way, part of exercising leadership is understanding and empathizing with the losses people are experiencing – and better yet, helping them to endure those losses. Leadership means helping a community move from the past into the future, and this journey requires support.

Sometimes, organizations are ready for adaptive work: the messy process of shifting values, norms, worldviews, and belief systems so that progress can be made. Other times, leadership means ripening the issue: groups cannot be forced to confront difficult challenges, but a localized urgency can be built into a generalized urgency, so the whole system feels activated and ready for adaptive work. Once a system is ready – that is, the issue is ripe, and the organization’s “relational glue” is sufficient – exercising leadership means making interventions that mobilize discussion, reflection, and learning. Groups are always looking for someone to “save” them, so a key facet of adaptive leadership is mobilizing others to take on the adaptive work.

Because most organizations regularly face adaptive challenges, it’s important to not only solve the current challenge, but also to develop adaptive capacity for the future. Adaptive cultures share five characteristics: 1) naming “elephants in the room” is the norm; 2) responsibility for the whole organization is shared across boundaries; 3) independent judgment is encouraged; 4) leadership capacity is developed; and 5) continuous learning is institutionalized. With these five qualities, groups are well-equipped to handle a changing world that creates constant pressure to adapt.
Figure 36. In technical challenges, disequilibrium spikes briefly, but an expert or authority can address the challenge quite quickly, and the challenge dissipates. Adaptive challenges, on the other hand, require a prolonged state of productive disequilibrium; exiting too early constitutes “work avoidance” and doesn’t sufficiently address the issue. No one knows a priori how the challenge will be solved (R. Heifetz et al., 2009).

To me, the best definition of leadership is also the simplest, and it comes from Jen Tutak, the creator of Harvard and MIT’s Graduate Student Leadership Initiatives. According to Tutak, “Leadership is love.” Love can be tough, or it can be gentle, but ultimately, love endeavors to build connection, capacity, trust, and safety. Especially in environmental conflicts – where leaders must be at peace with their own grief to provide a container for others’ (Moser, 2012) – Tutak’s definition acknowledges that leadership is difficult, but worthwhile if grounded in love.

In the following sections, I survey four skills that leaders will likely find useful, regardless of which definition of leadership is employed. In particular, I survey communication, negotiation, and storytelling – as well as self-awareness, which underpins the other three.
3.3.1. Communication

"One can lack any of the qualities of an organizer — with one exception—and still be effective and successful. That exception is the art of communication. It does not matter what you know about anything if you cannot communicate to your people. In that event you are not even a failure. You're just not there."
– Saul Alinsky, Rules for Radicals.

Basics

According to Jean-luc Doumont, “Effective communication is getting messages across” (Dumont, 2009): not just What, but So what. Doumont offers three basic principles for communicating effectively: 1) Adapt to your audience; 2) Maximize the signal-to-noise ratio; and 3) Use effective redundancy. For persuasion, Aristotle provides an additional framework consisting of ethos, logos, and pathos (Aristotle & Kennedy, 2007) – or, credibility, logic, and emotion. Finally, Nancy Duarte writes that the most powerful tool for commanding an audience’s attention is contrast (Duarte, 2010).

Planning

In planning communications – visual, verbal, or written – Doumont recommends answering five questions: why, who, what, when, and where? “Why” is an audience-centric question: what should the audience do (or be able to do) when they’re finished? “Who” takes into account an audience’s demographic, disposition, and knowledge: what are their lifestyles? Their backgrounds? Their fears, motivations, and influences?

“What,” according to Duarte, starts with a big idea: a complete sentence that conveys the speaker’s point of view and articulates the stakes. She then suggests brainstorming content from the head, heart, gut, and groin – and describing both the world as it is, and how it could be – to generate diverse content. “What” also offers an opportunity to address the audience’s resistances, misunderstandings, and obstacles. In political communication, framing can address (or fail to address) audience’s concerns before they’re even conscious of them; by adopting the conservative language of “tax relief” in debates, for example, liberals unwittingly support the conservative framing of taxation as a burden, rather than as an investment or a
membership fee (Lakoff, 2014). Similarly, “climate change” frames the issue as less threatening than, say, “climate crisis” or “climate cancer.” Frank Luntz, a Republican pollster, wrote in a 2002 memo to President Bush, “As one focus group participant noted, climate change ‘sounds like you’re going from Pittsburgh to Fort Lauderdale.’ While global warming has catastrophic connotations attached to it, climate change suggests a more controllable and less emotional challenge” (Luntz, 2002). Intentional framing is therefore a core part of answering, “What?”

“When” and “Where” are simpler – these are the time and space constraints on the communication – but Doumont implicitly also answers a sixth question: “How?” He recommends using a tree-like structure to organize the content into messages that can be digested by the audience.

![Figure 37. A tree-like structure can organize content into messages that can be digested by an audience (Dumont, 2009).](image)

*Designing*

Once a communicator has arranged messages into a coherent structure, it’s time to implement the outline. Unfortunately, PowerPoint’s default settings encourage poor communication standards, leading many users to create ineffective lectures, pitches, and talks (Alley, 2013). If used properly, however, PowerPoint slides can serve as effective visual aids for learning, even in technical settings (Garner & Alley, 2013).
In information-dense presentations, “assertion-evidence” slides (Garner & Alley, 2013) offer an easy way to satisfy Doumont’s three laws of communication. By including on each slide a single assertion and visual evidence for that statement, presenters can adapt to their audience’s level of understanding; this slide design also minimizes noise, and furthermore, the message is repeated three times – it’s spoken, it’s written, and it’s visualized – constituting effective redundancy. In non-technical presentations, Garr Reynolds offers an even simpler approach (Reynolds, 2019): big, beautiful images on each slide, with the occasional number or word for emphasis.

![Graph](image)

**Figure 38.** Example of an assertion-evidence slide taken from EarthDNA’s Climate 101 workshop.

The “evidence” in these presentations – and, for that matter, visual communications in general – should also adhere to the process noted above. First, designers should ask themselves what the audience should do (or be able to do) after seeing the visual, as well as who the intended audience is (Doumont, 2009). Then they can hone in on the message they want the visual to convey: what is this really about (Nussbaumer Knaflic, 2015)? With abstract concepts, Felice Frankel and Angela DePace suggest finding the core idea, the central part of a message, and expressing it as a visual metaphor (Frankel & DePace, 2012). They also agree with Doumont, Duarte, and Edward Tufte that designers should focus on the data and de-emphasize everything else (Doumont, 2009; Duarte, 2010; Frankel & DePace, 2012; Tufte, 2001). Ultimately, “the right graph is the one that’s easiest for your audience to read” (Nussbaumer Knaflic, 2015).
As for writing, Doumont’s three laws apply here as well. William Zinsser writes, although writers should not worry whether a reader likes them or agrees with them, it’s the writer’s fault if the reader “dozes off in the middle of your article because you have been careless” (Zinsser, 2006) – adapt to your audience. He also suggests writers “strip every sentence to its cleanest components” and ask themselves, “Is every word doing new work?” – maximize signal-to-noise ratio. Zinsser adds, however, that writers should sound like themselves, they should paint clear pictures; and they should consider rhythm in everything they write. As for effective redundancy, Zinsser describes the importance of “unity”: every successful piece of nonfiction should leave the reader with exactly one idea, and writers should be consistent about tense, tone, scope, and their relationship with the reader.

**Delivering**

Communicators cannot settle for delivering information; to be effective – that is, to be memorable and compelling – they must create experiences (Duarte, 2010). At a bare minimum, speakers should eliminate noise. They should learn to appreciate silence and beware of hedging words or nervous tics that undermine their credibility (Doumont, 2009). Visual and vocal delivery should convey presence, stability, and sincerity (Doumont, 2009). This means varying tone, pace, and volume, as well as minding facial expressions, posture, and hand gestures (Doumont, 2009). Ultimately, language is both functional and emotional (Garfinkle, 2012). To be a good speaker, then, is to be attuned to one’s emotions – and furthermore, to share them with the audience, an act which demands vulnerability and confidence. For communicators, speaking is not simply an act of self-expression; the mere act of speaking causes listeners to think about the topic, and, according to “agenda-setting theory,” to ascribe importance to it (Cialdini, 2018). JFK said it best: “The only reason to give a speech is to change the world.”

3.3.2. **Negotiation**

“Like it or not, you are a negotiator. Negotiation is a fact of life… [It] is a basic means of getting what you want from others… Whether in business, government, or the family, people reach most decisions through negotiation.” – Roger Fisher and William Ury, *Getting to Yes.*
Negotiation is “back-and-forth communication designed to reach an agreement when you and the other side have some interests that are shared and others that are opposed” (Roger Fisher, Ury, & Patton, 2011). According to Bruce Patton, there are seven key elements in negotiation: parties and interests, alternatives, options, legitimacy, relationships, communication, and commitment (Patton, 2005). I discuss them sequentially here, but in practice, these elements are highly dynamic and require constant revisiting.

**Seven elements of negotiation**

Arguably the most important element are the parties and interests: who’s involved in the negotiation, and what do they want (Patton, 2005)? Negotiators should create a map of parties, both at and away from the table (D. Lax & Sebenius, 2006), so they can identify potential allies and “high-value” parties, anticipate negative influences and potential blockers, and expand the map of parties strategically. Furthermore, this party map helps separate the people from the problem (Roger Fisher et al., 2011). Negotiators should also map the interests of the parties “early and often” (D. Lax & Sebenius, 2006), focusing not on positions – what people say they want – but rather on what really matters to the parties – why they want it. For example, job negotiations often fixate on near-term compensation, even when the real value can be found in opportunities for advancement. Mapping interests explicitly can also help negotiators avoid deducing their counterparts’ intentions from their own fears, which can derail discussions (D. Lax & Sebenius, 2006). And by identifying their own interests, negotiators can push for what they’re for, rather than what they’re against – a much more effective approach (Ury, 2007).

Next, negotiators should consider alternatives: if the deal falls through, what would each party do? What does each side have as a “Plan B” (Wheeler, 2013), also known as its Best Alternative to Negotiated Agreement (BATNA)? Moreover, how can each side influence the other’s BATNA or perception of it (Roger Fisher et al., 2011)? The BATNA helps inform the reservation price, also known as the “walk-away” price – the price at which agreement no longer makes sense – and it protects negotiators from accepting deals that don’t advance their long-term interests (Wheeler, 2013). Negotiators may be tempted to use their alternatives as threats, but they should keep in mind that threats tend to evoke “irrational” psychological resistance in the threatened parties, as well as “poisoning” future relationships (Watkins & Rosegrant, 1996). Alternatives and their details are therefore usually best kept private (Roger Fisher et al., 2011).
Next, negotiators should consider options that may satisfy both parties’ interests. Negotiators should avoid single-issue negotiations; it’s better to split issues, such that trading across issues become possible (Malhotra, 2018). Negotiators should also avoid fixating on their positions, also known as “positional bargaining”; it’s very rare that only a single position could actually satisfy the deeper, underlying interests (D. Lax & Sebenius, 2006). Finally, in brainstorming options, it’s important to see the other side as a partner, regardless of the type of disagreement, as it is hard to empathize or collaborate with “opponents” (Malhotra, 2018). This attitude allows for a higher chance of “expanding the pie” of available value (D. Lax & Sebenius, 2006) and discovering the zone of possible agreement (Wheeler, 2013), in which both parties are able to advance their interests.

Another element to consider is legitimacy: what are the objective criteria that each side can use as sword and shield, and which topics should be set aside because of uncertainty (Patton, 2005)? Negotiators can “educate” the other side, but it’s best to “let reality be their teacher” (Ury, 2007); in other words, negotiators can negotiate “on behalf of” objective criteria, which can often feel more comfortable than negotiating on their own behalf (Roger Fisher et al., 2011).

Next, negotiators should consider the relationships involved (Patton, 2005): do they have a history? Will they have a future? What are the norms? In many cases, relationships are important for their own sake. Even when that’s not the case, however, creating subjective value – establishing a sense of trust and fairness, and making the other party feel good about themselves and the negotiation – can help generate economic value in future negotiations (Curhan, Elfenbein, & Eisenkraft, 2010). It’s also important that negotiators safeguard their credibility – even when it’s costly – as reputation is sometimes their only source of leverage (Malhotra, 2018). Smart alternatives to lying include preparing for likely questions, refusing to divulge certain information, and adopting the “logic of exchange” by treating information as a tradeable currency (Malhotra, 2004). Ultimately, most deals are 50% emotion and 50% economics (D. Lax & Sebenius, 2006), so maintaining a positive relationship is highly advisable wherever possible.

Another key element for negotiators is communication (Patton, 2005). A good negotiator controls the frame of the negotiation (Malhotra, 2018), so the other side sees it the way he or she wants them to – usually as a collaboration or a problem-solving effort, rather than as a negotiation. The medium matters, too; different media entail different reaction times and different levels of personal contact, which can
benefit one side or make the negotiation easier (Parlamis & Ames, 2012). It can also be helpful to label concessions, which show a credible signal of commitment of good faith (Malhotra, 2018). Ultimately, respect is paramount to all communications aimed at reaching agreement (Ury, 2007).

Patton’s last of the seven elements is commitment (Patton, 2005): what would be a realistic outcome of the meeting, and how can it be prepared for? It can be helpful here to adopt the stance that “Nothing is agreed until everything is agreed.” (Malhotra, 2018). Furthermore, to reach commitment, negotiators can “build their counterparts a golden bridge” (Ury, 2007) – that is, they can make it easy for their counterparts to save face, to convince their constituency, and to say yes.

Power

A final element that I believe merits its own discussion is the idea of power, which in negotiations is defined as an ability to influence the decisions of others, assuming they know the truth (Roger Fisher, 1983). Roger Fisher writes that power can come from skill and knowledge, from good relationships, from a strong BATNA, from an elegant solution, from moral legitimacy, or from prior commitment (e.g. “I won’t go any lower!”). It can therefore be more useful to ask what kind of power each party has, rather than asking who has more. Still, the more power a negotiator exercises, the more respect they need to show (Ury, 2007).

Value claiming and value creation

When it comes to the practice of deal-making in real-time, negotiators can either claim value or create value (Raiffa, 1985). In value claiming, negotiators keep information hidden, threaten to withdraw their collaboration, and anchor (make the first offer) around an advantageous reference point. They treat the process as a competition: one party gains value only at the expense of the other (D. A. Lax & Sebenius, 2011). Value claimers also may resort to difficult tactics, or else attempt to persuade their counterpart via scarcity, social proof, authority and other mechanisms of persuasion (Cialdini, 2018). In value creation, on the other hand, negotiators treat the process as a mutual problem-solving effort, sharing information and cooperating to achieve a satisfactory outcome for all parties (D. A. Lax & Sebenius, 2011). Value creators maintain positive relationships with their counterparts, and they seek win-win solutions, such as, for example, trading away a higher salary for more vacation days. This requires adopting a learning stance,
rather than a message delivery stance (Stone et al., 2010), as well as keeping the negotiation framed around interests, options, and legitimacy, rather than turning it into an exercise of power. Value creation may also involve using a “Positive No” (Ury, 2007), which consists of a “Yes!” to one’s own interests, a “No.” to the counterpart’s request, and a “Yes?” that invites a different way to proceed.

![Figure 39](image)

**Figure 39.** This graph illustrates the ideas of value claiming and value creation (Raiffa, 1985). The x-axis represents gains to Party A, while the y-axis represents gains to Party B. Each blue dot represents a possible agreement between the parties. The blue arc represents the “Pareto frontier,” the points at which one party can make more gains only at the expense of the other. All available deals are located between the origin (where the sum of the parties’ gains equals zero) and the Pareto frontier (where the sum of the parties’ gains is maximized). In value creation, the parties generate options and make trades to support each other, moving the agreement away from the origin and towards the Pareto frontier. In value claiming, the parties jockey to move parallel to the frontier; one party receives gains only at the expense of the other. Now, assessing Deal 1, it’s clear that Party B has claimed much more value than Party A, because the y-coordinate is bigger than the x-coordinate. Nonetheless, much of the value is still available, as the deal is not on the Pareto frontier – perhaps because the parties were not sufficiently open about their own interests, preventing them from trading in ways that would have created win-win options. Had the parties cooperated more effectively, they could have reached Deal 2, creating more value for Party B without affecting Party A, or Deal 3, creating more value for Party A without affecting Party B.
Complicating matters is the fact that value claiming tactics and value creation tactics are mutually exclusive: it can be hard to know when to compete and when to cooperate. This is called “The Negotiator’s Dilemma” (D. A. Lax & Sebenius, 2011), and it mirrors the famous Prisoner’s Dilemma, wherein both parties are incentivized to claim value (“defect”), rather than create value (“cooperate”), leading to sub-optimal outcomes for everyone. Unlike the traditional prisoner’s dilemma, however, most negotiations consist of more than one interaction. This adjustment changes the calculus: in repeated Prisoner’s Dilemma games, “defect” is no longer the optimal option. Rather, it becomes “tit-for-tat”: start by cooperating, then do whatever the counterpart did in the previous round. Negotiators can therefore adopt a tit-for-tat strategy: start with a value creation posture; if the counterpart is uncooperative, switch to value claiming; if they become cooperative, switch back to value creation. In other words, be nice, be clear, be provocative, and be forgiving. This strategy applies both to the substance of the negotiation, as well as to the process of the negotiation, which can advantage one side or the other. By solving The Negotiator’s Dilemma, negotiators can advance their interests while maintaining their relationships.

3.3.3. Storytelling

“Stories are the most powerful delivery tool for information, more powerful and enduring than any other art form… Stories link one person's heart to another. Values, beliefs, and norms become intertwined. When this happens, your idea can more readily manifest as reality in their minds.” – Nancy Duarte, Resonate.

Stories express how and why life changes (Nussbaumer Knaflic, 2015). The basic story pattern is, “A relatable and likable hero encounters a roadblock and emerges transformed” (Duarte, 2010). Or, simply: a challenge, a choice, and an outcome (Ganz, 2014) – a structure that applies to film, music, dance, fiction, and other media. The basic unit of narrative is the moment: stories center around moments of pain and moments of hope, each of which contains enough sensory detail about the protagonist’s struggles to create a vivid experience for the listener (Ganz, 2014).

The hero’s journey proceeds as follows (Nussbaumer Knaflic, 2015): at first, the hero lives in an ordinary world, a base reality; then, a call to adventure summons the hero, raising the dramatic question that will be answered in the climax; the hero, lacking skills or perspective, struggles to achieve their goal until they are transformed; finally, the plot resolves, questions are answered, and listeners learn a valuable lesson. As
mentioned previously, storytelling in the form of a public narrative – story of self, story of us, story of now – provides a powerful structure for turning storytelling into leadership.

**Figure 40.** Stories start with a protagonist in an ordinary world, until an inciting incident (a challenge) provokes them into venturing out. They struggle until they reach a climactic moment of truth (a choice), and then they come home to a new reality and a final resolution (an outcome).

When communicators apply storytelling techniques to a presentation or paper, the audience becomes the hero of the story, the presenter their humble adviser (Duarte, 2010). The speaker begins with the realities of the audience’s current world; then, they call the audience to adventure by identifying a challenge or opportunity; next, the speaker guides the audience, alternating between moments of pain and moments of hope – between what is and what could be – until finally, the speaker ends on a higher plane, having shown the audience how to address the challenge or opportunity that was presented initially. Through storytelling, the speaker offers both a lesson of the head, and a lesson of the heart.

### 3.3.4. Self-awareness

“Most people do not accumulate a body of experience. Most people go through life undergoing a series of happenings, which pass through their systems undigested. Happenings become experiences when they are digested, when they are reflected on, related to general patterns, and synthesized.” – Saul Alinsky, *Rules for Radicals.*
Self-awareness underpins communication, negotiation, storytelling, and many of the other activities that comprise leadership. Self-aware people make sounder decisions, express more creativity, and build better relationships (Sutton, Williams, & Allinson, 2015). Moreover, even though more than half of people consider themselves self-aware, studies show the actual number is closer to ten percent (Eurich, 2018).

Researchers distinguish between internal and external self-awareness (Eurich, 2018). Internal self-awareness reflects our knowledge of our own values, aspirations, strengths, behaviors, and reactions. External self-awareness reflects our knowledge of how others see us – again in terms of our values, aspirations, strengths, behaviors, and reactions.

**Benefits of internal self-awareness**

Studies show that internal self-awareness correlates with higher job satisfaction, relationship satisfaction, and other qualities that lead to happiness, while also diminishing anxiety and stress (Eurich, 2018). One author describes the idea of “True North,” which represents “who you are at your deepest level” (George & Gergen, 2015); he says this internal compass not only guides you, but also attracts others, as internal self-awareness leads to self-acceptance, self-actualization, and comfort with vulnerability.

One clear benefit of internal self-awareness is an improved ability to listen. As peace activist Thich Nhat Hanh writes, we should listen with the intention of helping someone “empty their heart” – but “if there is a lot of suffering in you, it is difficult to listen to other people… First you have to look deeply into the nature of your anger, despair, and suffering to free yourself, so you can be available to others” (Nhat Hanh, n.d.). Neuroscience supports the claim, according to trauma specialist Bessel van der Kolk, that “the only way we can change the way we feel is by becoming aware of our inner experience” (Van der Kolk M.D., 2015).

In terms of storytelling, communication, and negotiation, self-awareness plays a critical role. Marshall Ganz writes that creating an authentic and compelling story of self requires “the courage of introspection, and even more courage in sharing what you discover” (Ganz, 2014). William Zinsser writes that “the product that any writer has to sell is not the subject being written about, but who he or she is” (Zinsser, 2006). And William Ury writes that “The deeper you go into your core motivation, the more powerful your Yes[i] will
be and thus the more powerful your No will be” (Ury, 2007) – and further, that “we cannot influence the other unless we are able to control our own reactions and emotions” (Ury, 2007).

Perhaps most importantly, self-awareness is crucial to continued growth. In Grit, Angela Duckworth explains that extraordinary skill is composed of elements that are each ordinary – but only by systematically identifying and improving weak components do people become, on the whole, extraordinary (Duckworth, 2018). This process, of course, requires continued awareness of strengths and weaknesses.

**Developing internal self-awareness**

Developing internal self-awareness can be arduous and painful. Abraham Maslow, who developed the hierarchy of needs, found that tragedy and trauma are key learning experiences on the way to self-actualization (George & Gergen, 2015). These crucibles offer opportunities for introspection that can “catalyze major breakthroughs” for finding meaning and achieving purpose (George & Gergen, 2015).

On a day-to-day basis, it can be helpful to reflect on – and write down – what went well and what to do differently in the future (Eurich, 2018). It can also be helpful to meditate, which helps people familiarize themselves with their typical thought processes and patterns (Tjan, 2015). Personally, I have found a useful exercise in staying silent in group settings, as the moments when I’m tempted to speak often reflect something about my priorities and “tunings.” For example, I often feel an impulse to speak to answer a question or provide information, reflecting an internal desire to play the role of information-giver – an important role, but one that can also seduce me into providing more certainty than I actually possess, leading a group astray. The practice of silence therefore allows me to discover my triggers, such that I can better manage them in future interactions.

In addition to introspection and experimentation, van der Kolk suggests that mindfulness and movement can cultivate self-awareness. He writes, for example, that body awareness “puts us in touch with our inner world,” and that focusing on bodily sensations can foster emotional regulation: “We do not truly know ourselves unless we can feel and interpret our physical sensations” (Van der Kolk M.D., 2015). Similarly, acting requires “exploring and examining your own internal experience so that it can emerge in your voice and body on stage” (Van der Kolk M.D., 2015). Yoga, theater, and dance can all improve self-awareness.
Benefits of external self-awareness

When people stay attuned to how others see them, they are perceived as more empathetic and more effective, empowering them as leaders (Eurich, 2018). In negotiation, for example, empathy begets power, as it expands the options available for resolving conflict (Malhotra, 2018). And before problem-solving can happen, each side must have their feelings acknowledged (Stone et al., 2010); thus, you can’t solve problems unless you become aware of your impacts on others around you. Without external self-awareness, problem-solving involves such high transaction costs that emotions have no outlet and problems fester (Stone & Heen, 2015). Also, external self-awareness supports communication and storytelling, as it helps speakers sound more authentic: “The reader will notice if you are putting on airs. Readers want the person who is talking to them to sound genuine” (Zinsser, 2006). Understanding others’ perceptions of you is therefore a key component of effective leadership.

Developing external self-awareness

Developing external self-awareness can be just as painful as developing internal self-awareness, but it hinges on feedback from friends, family, and coworkers. According to Bruce Patton and Sheila Heen, the key player in a feedback interaction is not the giver, but the receiver (Stone & Heen, 2015). They point out that most people aren’t good at teaching – so for those who want to develop awareness, they need to learn from anyone. One way to ease this process is to “complexify” your identity via the “And” stance (Stone et al., 2010): rather than harboring brittle identity labels like “I am good” – which forces the listener to dismiss feedback rather than endanger their sense of self – leaders can move to a more nuanced view of themselves, like “I try my best to be good, and I make mistakes.” Moreover, the authors recommend a learning stance: not “That’s wrong,” but rather, “Tell me more” (Stone & Heen, 2015). Most proactively, leaders can solicit feedback directly; questions like, “How do I get in my own way?” can offer insight into how others see them.

With sufficient self-awareness – both internal and external – leaders can embrace the difficult distinction between self and role (R. A. Heifetz & Linsky, 2017). Roles depend on other people’s expectations; self depends on an internal capacity irrespective of others. When people react to someone exercising leadership, they are actually reacting to the role that person plays, and whether the person has played it in accordance
with their standards – but they are not reacting to the person themselves. Whether someone attacks or promotes a leader, then, their decision depends on what the leader represents – the role they play – rather than the leader’s self – the vessel that contains their identities, experiences, and values. Although each role expresses a different facet of a leader’s self, no role captures the whole person. Leaders can therefore anchor in their selves, rather than in their roles, to better withstand the pressures of leadership – but again, this requires substantial self-awareness.

3.4. Conclusion

This chapter provided context on community organizing, climate education, and leadership. Organizing is “leadership that enables people to turn the resources they have into the power they need to make the change they want.” Organizers build relationships, tell stories, create structure, devise strategy, and take action. Furthermore, climate education is ripe for development: although young people make ideal messengers for spreading awareness, the education sector does not yet have the capacity to teach climate change, partially due to systemic challenges within the sector. Researchers have developed recommendations to improve climate literacy, but ultimately, educators must conduct both technical work (e.g. new teacher trainings), as well as adaptive work (e.g. reevaluating the importance of a rational mind relative to emotional and somatic development). Finally, leadership is love. To help communities move from the past into the future, leaders often need negotiation, communication, and storytelling skills. Communication means getting messages across, not just information. Negotiation means balancing assertiveness and empathy. Storytelling means sharing key moments of pain and hope that connect with listeners. Most importantly, leaders need a strong sense of self-awareness, both external and internal, to help them maintain curiosity and empathy. In the next chapter, I illustrate how community organizing, climate education, and leadership intersect in a new organization for climate leaders, EarthDNA Ambassadors.
4. Community organizing for climate education

One day, the world will unite in climate action. Until then, EarthDNA connects leaders, empowers students, and engages communities to build this future. This chapter, organized by EarthDNA Ambassador sub-team – Team Connect, Team Empower, and Team Engage – summarizes and discusses the research results of EarthDNA Ambassadors. In particular, Team Connect recruited dozens of Ambassadors, providing a valuable community for climate leaders to support each other personally and professionally. Team Empower delivered EarthDNA’s leadership training program, improving Ambassadors’ skills at negotiation and communication, as well as cultivating growth mindset. As one Ambassador shared anonymously, “While the focus may be climate change, [the training program] teaches skills that are helpful in every facet of life.” And Team Engage delivered EarthDNA’s Climate 101 workshop, improving climate literacy and behaviors. While it seems unlikely that a one-time intervention would produce lasting change, Climate 101 creates a “privileged moment” in which participants are more likely to increase their involvement in climate activism.

4.1. EarthDNA connects leaders

Team Connect has recruited dozens of Ambassadors, providing a valuable community for climate leaders to support each other personally and professionally.

Although EarthDNA is still a small organization, we have already started connecting leaders from various other groups, including Sunrise Movement, Scientists Speak Up, and March for Science. By positioning ourselves as a training hub, EarthDNA can continue attracting environmental activists, forging connections through shared experience in Ambassador training and beyond. In an anonymous survey, which sought to measure changes over the course of our ten-week training program, there were many comments about the benefits of the EarthDNA community. These comments are best encapsulated by this response to, “What was your favorite part of EarthDNA’s leadership training?”: “The community: developing relationships, learning from others’ stories, and helping them to become more self-aware. It is energising to interact with others that share similar values and goes some way to combat the paralysis of climate anxiety.” The survey is discussed in more detail in the following section.
In addition to the Ambassadors who actively contribute to EarthDNA’s mission, EarthDNA also maintains an email list with several hundred members and a brand-new Instagram account with ~50 members. These resources offer a way for EarthDNA to maintain a constituency of followers – people who care about climate change, but cannot commit several hours a week to the cause. Just as the NRA – a highly successful advocacy group, regardless of one’s political beliefs – can mobilize over five million members, EarthDNA Ambassadors aims to support the development of political muscle for climate action. Ambassadors on Team Connect not only manage EarthDNA’s recruitment and partnerships, but also a broader constituency for building the public will to act on climate change.

### 4.2. EarthDNA empowers students

Team Empower has trained dozens of Ambassadors. EarthDNA’s leadership program improves Ambassadors’ skills at negotiation and communication, as well as cultivating growth mindset. As one Ambassador shared anonymously, “While the focus may be climate change, [the training program] teaches skills that are helpful in every facet of life.”

Through our 10-week leadership program, Ambassadors gain skills and knowledge that change the way they see and interact with the world. Ambassador training starts with an intense focus on self-awareness, as leaders can achieve their goals only if they know what they want and why. From there, Ambassadors learn how to tell stories that motivate action, negotiate agreements that advance their interests, and communicate messages that make an impact. Throughout the ten weeks, Ambassadors meet in independent reading groups to discuss weekly, climate-related readings. At the end of the program, Ambassadors join Team Connect, Empower, or Engage to further EarthDNA’s mission.

Figure 41. Leadership training starts with a foundation in self-awareness, then cultivates Ambassadors’ capacity for listening and empathy, then dives into skills-training for negotiation, storytelling, and communication.
The structure of EarthDNA’s leadership training – inspired by Rand Wentworth’s Environmental Leadership course at the Harvard Kennedy School (HKS) – is described below:

Module One [inspired by Jen Tutak’s Graduate Student Leadership Initiative at HKS and MIT]: Module One serves as the foundation for the rest of training. Ambassadors reflect on their experiences and behaviors, prompting them to make discoveries about what’s important to them and why. They also learn the process of navigating difficult conversations: an early, but crucial example of applying self-awareness to real-world interactions. Ultimately, by inviting Ambassadors to coach each other in small groups, Module One cultivates the core leadership skills of empathy, listening, and introspection.

Module Two [inspired by Marshall Ganz’s Public Narrative workshop at HKS]: In Module Two, Ambassadors learn to tell their personal stories in service of building a movement. Specifically, they develop their public narratives: a story of self to connect themselves to the audience; a story of us to connect the audience to each other; and a story of now to connect everyone to the present moment. This module builds Ambassadors’ capacity for storytelling and self-reflection. By the end of Module Two, Ambassadors gain deeper insight into their own values and experiences, and learn a storytelling process by which they can motivate audiences to act collectively and urgently.

Module Three [inspired by Jared Curhan’s Negotiation Analysis course at MIT]: We negotiate every day. Our coworkers, bosses, siblings, parents, friends, and enemies all seek behaviors from us, and likewise, we from them. How, then, can we advance our interests? Moreover, how can we balance assertiveness with empathy? This module offers interactive experience negotiating agreements, culminating with a multi-party, multi-issue negotiation. Ambassadors gain an understanding of negotiation basics, including value claiming, value creation, and the seven elements of negotiation. The sessions also include discussions of power and barriers in negotiation. Finally, students receive feedback from their peers to encourage personal reflection and growth. Ambassadors are required to create accounts with iDecisionGames to access negotiation simulations and debrief materials.

Module Four [borrowed from the author’s Climate Media course at MIT]: In the fourth and final module, Ambassadors learn to craft compelling speeches, papers, and graphics. The first workshop
offers a broad overview, while the next three dive deep into planning, designing, and delivering a message. By the end, students feel empowered to organize and share their ideas to make an impact. The final workshop concludes EarthDNA Ambassador training with a celebration and next steps.

Although workshop time is devoted to leadership training, as the skills above are best learned experientially, EarthDNA training also asks Ambassadors to complete and discuss weekly readings in small groups to enhance their understanding of climate change. The ten weeks of readings are summarized below:

1. An introduction to climate organizing by authors like Anthony Leiserowitz and Marshall Ganz. These readings offer context on the current state of the climate movement, as well as motivating the work of EarthDNA Ambassadors.
2. An introduction to the science of climate change, provided by NASA’s climate portal. This reading includes the causes, effects, and evidence for climate change.
3. An introduction to the consequences of climate change, described by the most recent National Climate Assessment. This reading includes a region-by-region analysis of climate impacts, as well as nation-wide impacts by sector. Ambassadors are asked to select a few sections of personal interest to read and discuss.
4. An introduction to environmental economics, provided by the Core Economics online textbook. This reading includes the ideas of tragedy of the commons, externalities, and carbon pricing.
5. Ambassadors to prepare for negotiation simulations.
6. Ambassadors to prepare for negotiation simulations.
7. An introduction to environmental justice, written by Robert Bullard. This reading provides a survey of racism in environmental contexts, as well as offering remedies and steps forward.
8. An introduction to the political and media dimensions of climate change, provided by Sheila Jasanoff and Naomi Oreskes. These readings include a discussion of climate skepticism and the climate change countermovement.
9. An introduction to climate solutions, as described in Project Drawdown. These include eighty ideas across nine sectors. Ambassadors are asked to select a few of personal interest to read and discuss.
10. Concluding readings on what it means to exercise leadership in environmental contexts. These include the importance of anchoring oneself and the role of grief in environmental leadership.
The complete Ambassador training workbook can be found in Appendix B.

Both before and after training, each Ambassador was asked how much they agree or disagree with the statements below:

- Good leaders are just born with it.
- I have a clear awareness of my values.
- I reflect on my experiences deeply and often.
- I’m comfortable receiving critical feedback.
- I’m good at listening to others.
- Good negotiators are just born with it.
- I am empathetic when I negotiate.
- I am assertive when I negotiate.
- I can manage difficult conversations.
- I enjoy negotiating.
- Good communicators are just born with it.
- I enjoy public speaking.
- I can plan presentations effectively.
- I can design presentations effectively.
- I enjoy telling stories.
- I can influence and inspire others to act.
- Climate change is mostly caused by human activities.
- I am worried about climate change.
- The government should do more to address climate change.

After training, Ambassadors were also asked the following open-ended questions:

- How would you describe EarthDNA’s leadership training to your friends?
- What was your favorite part of EarthDNA’s leadership training?
- What would have helped you learn more effectively?

EarthDNA’s training program yielded statistically significant shifts ($p < 0.05$) in communication and negotiation skills, as well as growth mindset. The following data comes from a group of 37 Ambassadors, 27 of whom finished the training. Eight of them were taught by the author, while the other 29 were taught by a team consisting of four, previously-trained Ambassadors.
Figure 42. Ambassador training develops negotiation and communication skills. After 10 weeks of EarthDNA’s leadership training, Ambassadors are more likely to agree with the statements “I am assertive when I negotiate,” “I can plan presentations effectively,” and “I can design presentations effectively.” The changes in means are, respectively, 0.89, 0.47, and 0.43 (n = 37 before training, 27 after training). This change demonstrates the acquisition of important leadership skills that serve Ambassadors both professionally and personally.

Figure 43. Ambassador training develops growth mindset. After 10 weeks of EarthDNA’s leadership training, Ambassadors are less likely to agree with “fixed mindset” statements: “Good leaders are just born with it,” “Good negotiators are just born with it,” and “Good communicators are just born with it.” The changes in means are, respectively, -0.52, -0.65, and -0.67, representing the shift of the average Ambassador towards growth mindset (n = 37 before training, 27 after training). Ambassadors are therefore better able to learn from feedback, rather than feeling criticized or hopeless, after training.
Not all of the survey questions yielded statistically significant shifts. For the following statements, there was no significant shift over the 10 weeks of training:

- I have a clear awareness of my values.
- I reflect on my experiences deeply and often.
- I’m comfortable receiving critical feedback.
- I’m good at listening to others.
- I am empathetic when I negotiate.
- I can manage difficult conversations.
- I enjoy negotiating.
- I enjoy public speaking.
- I enjoy telling stories.
- I can influence and inspire others to act.
- Climate change is mostly caused by human activities.
- I am worried about climate change.
- The government should do more to address climate change.

Student feedback suggests that those who completed the program found the training meaningful and useful. Answers to the question, “How would you describe EarthDNA’s leadership training to your friends?”, include the following responses:

- “It’s a training program that teaches you about yourself and about how to effectively interact with others. While the focus may be climate, it teaches you skills that are helpful in every facet of your life.”
- “You go through four modules that will give you self-awareness, tools, and information… You will leave feeling empowered and comfortable holding conversations without shutting down your listener.”
- “You learn more about yourself, you improve your communication and interpersonal skills, you meet interesting people from different places and backgrounds, [and] you see climate change from a completely different perspective.”
- “Reflective, meditative, and therapeutic!”

4.2.1. Discussion

Based on surveys and feedback, EarthDNA Ambassador training offers three concrete benefits. First, it offers a community to people passionate about a topic that can induce anxiety and sadness. Second, it confers confidence and skill with respect to negotiation and communication. Finally, it helps Ambassadors
develop a “growth mindset” (Dweck, 2007) – the idea that skills are not innate, but rather can be learned. This finding is particularly surprising, given that the training never mentions this concept. Nonetheless, as reflected by the shifts in people agreeing with statements like, “Good ___ are just born with it,” Ambassadors clearly changed their mindset around learning to lead. According to Carol Dweck, this mindset shifts people’s focus from protecting their reputation to identifying and addressing their weaknesses (Dweck, 2007). And although it’s possible this shift was caused by a higher dropout rate among those without a growth mindset, most people who did not finish the program cited scheduling issues, rather than a lack of interest in the program, making the latter explanation unlikely. These benefits reflect the intensely personal nature of the program; Al Gore’s Climate Reality Project also offers climate leadership training, for example, but that program takes fourteen hours, rather than EarthDNA’s fifty, and it offers mostly “external” work – climate information and communication strategies – rather than space for “internal” development (Climate Reality Project, 2021).

As for questions where there was no significant change, several factors may have contributed. For statements like, “I have a clear awareness of my values,” it may be that pre-training Ambassadors had such limited self-awareness, they were not even aware they lacked awareness; if this sounds harsh, remember that 80% of people who consider themselves self-aware are incorrect (Eurich, 2018). Even if people developed a better sense of self-awareness, the surveys may not have captured it. For statements like, “I’m good at listening to others,” or “I am empathetic when I negotiate,” the change may be due to insufficient training, but another contributing factor may be that climate activism is wrapped in empathy and compassion; rating themselves poorly on this scale before training may have been counter to Ambassadors’ identities. For statements like, “I enjoy public speaking,” the Ambassador training program may have attracted people who already enjoy the activities of leadership; in that case, training would create only an insignificant shift in people’s perspectives. Finally, for climate-related statements, it makes sense that no significant change occurred; people who sign up for 10 weeks of climate leadership training are sufficiently alarmed by the issue of climate change, and it’s not necessary (or even desirable) to alarm them further.

For some statements, such as “I can influence and inspire others to act,” we made concrete changes to our curriculum to improve the outcomes. But for many of the others, we expect that change simply takes longer. Ambassador learning continues even after training; one quality of an adaptive organization is creating space for individual and collective reflection (R. Heifetz et al., 2009), and, although there is already frequent,
informal coaching, we are working to implement feedback and learning systems in a more formal way. People on Team Engage, for example, practice storytelling for an additional 4 weeks before running Climate 101 workshops, and people on Team Empower keep a list of what “Went Well” and what to “Do Differently” after each of their teaching sessions.

4.3. EarthDNA engages the world

The final component of EarthDNA Ambassadors is external outreach, which “ripen[s] the issue” (R. Heifetz et al., 2009) of climate change. Most people do not see themselves represented in the climate movement, because most people are not scientists, environmentalists, or liberals (Leiserowitz, 2019). Ambassadors therefore deliver workshops to inspire climate conversations in their communities. In particular, Ambassadors share EarthDNA’s Climate 101, an interdisciplinary, interactive workshop that covers the science, economics, and politics of climate change. From the perspective of Ambassadors, each Climate 101 workshop is successful to the extent that it catalyzes climate conversations – productive disequilibrium – in new places within a community.

Delivered by Team Engage, EarthDNA’s Climate 101 workshop improves climate literacy and behaviors. Climate 101 creates a “privileged moment” in which participants are more likely to increase their involvement in climate activism.

Figure 44. The outline slide of Climate 101. The forty-five minute workshop is split evenly between lecture, videos, discussion, and a game that simulates the tragedy of the commons (Sweeney, Meadows, & Mebers, 2011). It adheres to the best practices described in Section 3.2: it’s tangible, meaningful, and hopeful, and it inoculates listeners against common misconceptions.
Figure 45. Sample slides from Climate 101. Top left: an introduction to the greenhouse effect. Top right: An explanation for why even modest warming is harmful. Bottom left: an introduction to a common policy proposal to address climate change. Bottom right: a choice between the past and the future, and inspiration for the audience to take action by talking about climate.

The complete Climate 101 workshop materials can be found in Appendix A, and a video of the author delivering Climate 101 is available here, as well as on MIT OpenCourseWare.

Presentations of Climate 101 to dozens of students resulted in significant shifts (p < 0.05) in their climate beliefs and behaviors. According to statistical analyses of surveys – one right before (n=83), one a week after (n=52) – students were more likely to talk about climate change and more likely to be aware of the scientific consensus on climate change after the workshop. These surveys were taken across three Climate 101 presentations, all before the Covid-19 pandemic, all in the Northeast, and all led by the author.
Figure 46. Climate 101 improves climate behaviors. One week after EarthDNA’s Climate 101, participants had an average of 2 more climate conversations per week ($n = 83$ before the workshop, $n = 52$ one week after). This change in climate behavior demonstrates a positive short-term impact from Climate 101, although it says nothing about long-term change.
Figure 47. Climate 101 improves climate beliefs. One week after EarthDNA’s Climate 101, participants were more likely to agree with the statements, “Climate change is mostly caused by human activities,” “Most scientists think climate change is happening,” and “I am worried about climate change.” The changes in means are, respectively, 0.39, 0.51, and 0.35 representing the shift of the average Ambassador towards growth mindset (n = 83 before the workshop, 52 one week after). This change in climate beliefs demonstrates a positive short-term impact from Climate 101.

As one MIT professor explained, students who attended Climate 101 “can now better understand the complexity of the problem we are facing, and the importance of not only fact-based arguments, but also of the social intelligence needed to navigate myths and work with different actors with various agendas.”

4.3.1. Discussion

Based on the change in how often people talk about climate change, Climate 101 achieves its purpose of catalyzing climate conversations – with several caveats. First, this data does not assess whether other presenters can be effective with Climate 101. It’s unlikely, however, that these benefits are limited to one presenter. This data is also limited to the Northeast US; an attempt to gather additional data was precluded by the emergence of Covid-19. Further work should be performed to assess the impact of Climate 101 across the US and internationally. The data also includes an unequal number of survey participants; perhaps students who were less engaged (and therefore less affected) were less likely to take the follow-up survey. Follow-up studies should link survey respondents to track how individuals change. In any case, it is unlikely
that this drop-out is the sole contributor to a difference in means of two additional conversations per person. Another challenge is the difficulty of assessing intergenerational learning. Surveying parents was deemed cumbersome enough that it would hinder the rest of the work; still, when participants were asked at the end of the workshop to share a list of five people with whom they’d talk about climate change, most lists included family members. It is also unclear whether these workshops are as effective online as they are in person; a live negotiation activity is the centerpiece, and it probably loses its impact in virtual settings (Ahn & McEachin, 2017; Hart, Berger, Jacob, Loeb, & Hill, 2019). Finally, while attempts were made to collect data one month after the presentation, response rates were so low as to make the data meaningless. In any case, it seems unlikely that a one-time intervention would producing lasting change without follow-on engagement. Perhaps the key benefit of Climate 101, then – in addition to creating a short-term spike in a community’s climate conversations – is creating a “privileged moment” (Cialdini, 2018): conditions that would briefly make people more likely to accept follow-up requests regarding climate change, such as invitations to join an environmental club, subscribe to a climate newsletters, or apply to EarthDNA’s leadership training.

4.4. Conclusion

This chapter reviewed the results of EarthDNA Ambassadors, an organization that connects leaders, empowers students, and engages the world on climate change. Team Connect recruited dozens of Ambassadors, providing a valuable community for climate leaders to support each other personally and professionally. Team Empower delivered EarthDNA’s leadership training program, a ten-week curriculum that offers valuable perspectives on climate change, improves Ambassadors’ skills at negotiation and communication, and most importantly, cultivates growth mindset. As one Ambassador shared anonymously, the program “teaches skills that are helpful in every facet of life.” Finally, Team Engage delivered EarthDNA’s Climate 101 workshop, improving climate literacy and behaviors. Climate 101 generates productive disequilibrium around climate change, creating a “privileged moment” in which participants are more likely to increase their involvement in climate activism. In the next chapter – acknowledging that mitigation efforts may no longer be enough, and that adaptation has become increasingly germane – I discuss the Earth Intelligence Engine (EIE), an approach to climate visualizations that helps decision-makers better understand climate risks.
5. Machine learning for climate impact visualization

Chapter five reviews literature on the application of machine learning (ML) for Earth, with a special focus on generative models, then summarizes and discusses the results of the Earth Intelligence Engine\(^a\) (EIE). In particular, we apply generative adversarial networks (GANs) to bridge the gap between machine learning, climate models, and decision-makers for flooding. Generative adversarial networks are a new type of neural network that can generate images and other data. We train a GAN to create physically-consistent, photorealistic satellite imagery of future flooding. Our GAN combines a pre-flood image and a physics-based input to generate a post-flood image. Training data comes from the xBD data set (for satellite images) and NOAA’s SLOSH model (for flood predictions). We combine two metrics into a Flood Visualization Plausibility Score (FVPS), which accounts for both photorealism and physical consistency. Our GAN outperforms other GANs and a handcrafted baseline. Our GAN learns that flooded vegetation looks greener and that elevated structures don’t get flooded, and it produces photorealistic images even given a low-resolution flood prediction.

5.1. Introduction

We apply generative adversarial networks (GANs) to ease communication between experts and decision-makers for flooding.

With the meteoric rise of ML in the last decade – plus an abundance of remote sensing data, both from public sources (ESA, n.d.; NASA LP DAAC, n.d.; U.S. Geological Survey, n.d.) and private sources (Maxar, n.d.; Planet Team, 2017) – researchers have found many applications of ML to Earth systems. For instance, researchers created a model that classifies satellite images by land cover (Robinson et al., 2019); spending one week and $5,000, they produced a high-resolution land-cover map of the contiguous United States – a process that usually takes many months and millions of dollars. Researchers have also trained a model that

\(^a\) This work was completed at the 2020 Frontier Development Lab in collaboration with Bjorn Latjens, Oceane Boulais, Christian Requena-Mesa, Farrukh Chishtie, and Natalia Diaz-Rodriguez, along with mentorship from Alex Lavin, Chedy Raisi, Yarin Gal, and Dava Newman.
classifies crops using Landsat-8 imagery (Kussul, Lavreniuk, Skakun, & Shelestov, 2017). One paper even showcases a neural network which, given a satellite image and its corresponding, land-cover segmentation map at 30 meters/pixel, produces a “super-resolution” segmentation map at 1 meter/pixel (Malkin et al., n.d.). The ML community have recently shown interest in climate change as an area of research.

ML researchers suggest a long list of projects for climate, including improving vehicle efficiency, optimizing buildings, monitoring peatlands, modeling climate impacts, and many other ideas (Rolnick et al., 2019). One recent paper demonstrates the first use of deep learning to segment “pixel-level” climate events like tropical cyclones, which could help automate the detection of extreme weather (Kurth et al., 2018). Another paper introduces DeepGlobe 2018, a public competition that aims to bridge gaps between remote sensing and computer vision, where organizers provide data, evaluation, and metrics for three challenges: road segmentation, building detection, and land cover classification (Demir et al., 2018). Organizers hope such work could lead to “major breakthroughs in global urban planning or climate change research.” Finally, a group of researchers has generated realistic, ground-level images of neighborhoods after extreme weather events due to climate change (Zhou, Luccioni, Cosne, Bernstein, & Bengio, n.d.).

These researchers are exploring many avenues to support climate mitigation and adaptation, but the paper by Sharon Zhou et al. offers a promising new area of work: if researchers have generated street-level images from the future, perhaps they could also develop satellite imagery from the future. Christian Requena-Mesa et al. have used Generative Adversarial Networks (GANs) to predict landscapes from environmental conditions (Requena-Mesa, Reichstein, Mahecha, Kraft, & Denzler, 2019), but this research, which serves as the inspiration for the work in this chapter, could be expanded to any number of climate-related phenomena, including future visualizations for wildfires, melting sea ice, or flooding.

In this chapter, I focus on flooding on the US East coast for several reasons. First, flooding is the most frequent disaster in the US (Centre for Research on the Epidemiology of Disasters & UN Office for Disaster Risk Reduction, n.d.), costing the country nearly $20B/year (Grimm, 2020). Second, flood model data and disaster imagery – scarcity of which often limits ML research – were readily available through NOAA SLOSH (Jelesnianski et al., 1992) and the xBD building damage dataset (Gupta et al., 2019), respectively. Finally, current flood visualizations are limited to informative overviews (NOAA, 2020; NOAA National Weather Service National Hurricane Center Storm Surge Prediction Unit, 2020) – non-
intuitive for non-experts – and street-view images (V. Schmidt et al., 2019) – too local for planning. Furthermore, interviews with a US Air Force Weather Officer confirmed the usefulness of generating more impactful visualizations of future flooding (Radovan, de Suarez, Loftis, & Coh, n.d.). By developing the first deep-learning pipeline to generate RGB satellite imagery of coastal floods, this work simultaneously provides intuition and information about floods. Ultimately, our relatable, engaging imagery can facilitate better flood-risk communication, improving short-term disaster response and long-term climate planning.

Figure 48. Existing coastal flood visualizations are either informative or intuitive, but not both. State-of-the-art flood visualizations include either color-coded geospatial rasters (top row), which can be nonintuitive to interpret, or photorealistic street view imagery (middle row), which is intuitive, but too narrow to provide an overview for city-scale climate resilience planning. Our visualizations (bottom row) are both intuitive and informative, while maintaining physical validity.
5.2. Technical background

Recent advances in GANs have generated photorealistic pictures ranging from faces (Isola, Zhu, Zhou, & Efros, 2016; T.-C. Wang et al., 2018b) and animals (Brock, Donahue, & Simonyan, 2019; Zhu, Park, Isola, & Efros, 2017) to satellite imagery (Frühstück, Alhashim, & Wonka, 2019; Requena-Mesa et al., 2019) and street-level flooding (V. Schmidt et al., 2019). Disaster planners and responders, however, need imagery that is not only photorealistic, but also physically-consistent. In our implementation, we consider both GANs and variational autoencoders (VAEs), where GANs generate more photorealistic imagery (Dosovitskiy & Brox, 2016; Zhu, Zhang, et al., 2017), but VAEs more precisely capture uncertainties (Casale, Dalca, Saglietti, Listgarten, & Fusi, 2018; Kingma & Welling, 2014). Because our use case requires photorealism to provide intuition, we extend a state-of-the-art, high-resolution GAN, Pix2PixHD (T.-C. Wang et al., 2018b), to take in physical constraints and produce imagery that is both photorealistic and physically-consistent.

There are multiple approaches to generating physically-consistent imagery with GANs, where we define physically-consistent to assess: Does the generated imagery depict the same flood extent as the storm surge model? One approach is conditioning the GAN on the outputs of physics-based models (Reichstein et al., 2019); another approach is using a physics-based loss during evaluation (Lesort, Seurin, Li, Diaz-Rodriguez, & Filliat, 2019); yet another is embedding the neural network in a differential equation (Rackauckas et al., 2020). Our work focuses on the first two methods, leveraging years of scientific domain knowledge by incorporating a physics-based storm surge model in the image generation and evaluation pipeline.

This work makes three contributions: 1) the first physically-consistent visualization of coastal flood model outputs as high-resolution, photorealistic satellite imagery; 2) a novel metric, the Flood Visualization Plausibility Score (FVPS), to evaluate the photorealism and physical-consistency of generated imagery; and 3) an extensible framework to generate physically-consistent visualizations of climate extremes.
5.3. **Approach**

Our GAN combines a pre-flood image and a physics-based input to generate a post-flood image. Training data comes from the xBD data set (for satellite images) and NOAA’s SLOSH model (for flood predictions). We combine two metrics into a Flood Visualization Plausibility Score (FVPS), which accounts for both photorealism and physical consistency.

The proposed pipeline uses a generative vision model to generate post-flooding images from pre-flooding images and a flood extent map:

![Diagram showing pre-flood image, physics-based input, and post-flood image generated by GAN]

**Figure 49.** We constrained generative vision models with physics-based inputs to visualize future flooding. Our GAN learns the relationship between pre-flood images, post-flood images, and flood masks. During inference, the GAN receives a satellite image of an area, as well as the flood-mask prediction of a physics-based model. These are then combined into a realistic satellite image of how the area would look if the flood prediction were to occur.

5.3.1. **Data overview**

Obtaining post-flood images that display standing water is challenging due to cloud-cover, time of standing flood, satellite revisit rate, and cost of high-resolution imagery. This work leverages the xBD dataset (Gupta
et al., 2019), a collection of pre- and post-disaster images from events like Hurricane Harvey or Florence, from which we obtained ~3,000 pre- and post-flooding image pairs with 0.5 meters per pixel and 1024x1024 pixels per image. More specifically, we used 3284 RGB image pairs, of which 30% display a standing flood, taken from hurricanes (Harvey, Florence, Michael, and Matthew, all on the U.S. East and Gulf Coast), spring floods (Midwest U.S., ‘19), a tsunami (Indonesia), and a monsoon (Nepal). Our evaluation test set was composed of 216 images evenly split from Hurricanes Harvey and Florence. The test set excludes imagery from Hurricanes Michael and Matthew, because the majority of tiles for these hurricanes do not display standing flood.

An important part of pre-processing the xBD data was correcting the geospatial reference for each image, so it could be used with US NAIP imagery. To align the imagery, we (1) extracted tiles from NAIP that approximately matched xBD tiles, (2) detected key points in both tiles via AKAZE, (3) identified matching key points via the L2-norm in image coordinates, (4) approximated the homography matrix between two feature matrices via RANSAC, and (5) applied the homography matrix to transform the xBD tile.

To obtain flood segmentations from the flooded images, we trained a segmentation model on 111 manually-annotated, post-flood images, i.e. segmentation masks that display flooded and non-flooded pixels. The model consisted of a vanilla U-Net for the generator that was trained with L1-loss, IoU, and adversarial loss; its last layers were fine-tuned solely on L1-loss. A four-fold cross validation was performed leaving 23 images for testing. The segmentation model selected to be used by the FVPS has a mean IoU performance of 0.343. Labelled imagery will be made available at the project GitLab.

Finally, we also downloaded flood hazard maps (30 meters per pixel) from SLOSH, NOAA’s storm surge model. Developed by the National Weather Service (NWS), the Sea, Lake and Overland Surges from Hurricanes (SLOSH) model (Jelesnianski et al., 1992) estimates storm surge heights from atmospheric pressure, size, forward speed and track data, which are used as a wind model driving the storm surge. The SLOSH model consists of shallow water equations, which consider unique geographic locations, features and geometries. The model is run in deterministic, probabilistic and composite modes by various agencies for different purposes, including NOAA, National Hurricane Center (NHC) and NWS. We use outputs from the composite approach – that is, running the model several thousand times with hypothetical
hurricanes under different storm conditions. We then aligned the flood hazard map with the flood images and reduced the hazard map into a binary flood extent mask, i.e. flooded vs. non-flooded.

Future work could use the state-of-the-art ADvanced CIRCulation model (ADCIRC) [45] model, which has a stronger physical foundation, better accuracy, and higher resolution than SLOSH. ADCIRC storm surge model output data is available for the USA from the Flood Factor online tool developed by First Street Foundation.

Note: we did not use digital elevation maps (DEMs), because the information of low-resolution DEMs is contained in the storm surge model, and high-resolution DEMs for the full U.S. East Coast are not publicly available.

5.3.2. Model architecture

Our pipeline centers on a generative vision model, which learns the physically-conditioned image-to-image transformation from pre-flood image to post-flood image. We leveraged the existing implementation of Pix2PixHD (T.-C. Wang et al., 2018b), a GAN, and extended the input dimensions to incorporate the flood extent map. This pipeline is modular, such that it can be repurposed for visualizing other climate impacts.

Figure 50. The generator in the Pix2PixHD network is based on the encoder/decoder architecture for image-to-image translation (T.-C. Wang et al., 2018a). At each layer of the encoder, convolutional filters detect certain “features” in the image, such as edges or color contrasts, and then output a smaller, processed version of the image, called a “feature map.” The decoder then reverses this process, using fewer and fewer filters and making the feature map bigger and bigger with each step. Thus the input image, e.g. a satellite image, is encoded into a feature space of sixteen filters and then decoded into a new image, e.g. a segmentation map.
5.3.3. **Evaluation metric**

Evaluating GAN-generated imagery is difficult (Borji, 2019; Xu et al., 2018). Most evaluation metrics measure photorealism or sample diversity (see, for example: FID (Heusel, Ramsauer, Unterthiner, Nessler, & Hochreiter, 2017), LPIPS (Zhang, Isola, Efros, Shechtman, & Wang, 2018), IS (Salimans et al., 2016)), but not physical consistency.

To evaluate physical consistency, we use intersection over union (IoU) between water in the generated imagery and water in the flood extent map. This method relies on flood masks, but because there are no publicly available flood segmentation models for RGB imagery, we trained our own model on 100 hand-labeled flooding images.

This segmentation model produced flood masks of the generated and ground-truth flood image which allowed us to measure the overlap of water in between both. When the flood masks overlap perfectly, the IoU is 1; when they do not overlap at all, the IoU is 0.

To evaluate photorealism, we used the state-of-the-art perceptual similarity metric Learned Perceptual Image Patch Similarity (LPIPS) (Zhang et al., 2018). LPIPS computes the feature vectors (of an ImageNet-pretrained deep CNN) of the generated and ground-truth tile and returns the mean-squared error between the feature vectors. Since it’s a distance metric, the best LPIPS score is 0, and the worst is 1.

With two metrics, we face a challenging hyper-parameter optimization problem. Therefore we combine physical consistency (IoU) and photorealism (LPIPS) into a new metric, the Flood Visualization Plausibility Score (FVPS).

The FVPS is the harmonic mean over the sub-metrics, IoU and 1-LPIPS, both of which are worst at 0 and best at 1. If either of the sub-metrics is 0, the FVPS is 0; if there’s a perfect match between prediction and reality – both in terms of photorealism and physical-consistency – the FVPS is 1.

\[
FVPS = \frac{2}{\frac{1}{\text{IoU} + \varepsilon} + \frac{1}{1 - \text{LPIPS} + \varepsilon}}
\]
5.4. Experimental results

Our GAN outperforms other GANs and a handcrafted baseline, which we generated with a simple algorithm for comparison. Our GAN learns that flooded vegetation looks greener and that elevated structures don’t get flooded, and it produces photorealistic images even given a low-resolution flood prediction. Sometimes, however, it smears buildings and other human-made structures.

In terms of both physical-consistency and photorealism, our physics-informed GAN outperforms an unconditioned GAN that does not use physics, as well as a handcrafted baseline model.

Table 1. The developed physics-informed GAN scores higher on the Flood Visualization Plausibility Score (FVPS) than all other models. The baseline GAN, pix2pixHD (e), in comparison, receives only a pre-flooding image and no physical input. The resulting image, (e), is fully-flooded, rendering the model untrustworthy for emergency response. The VAEGAN, BicycleGAN (f), creates error-prone imagery. A handcrafted baseline model (g), as used in common visualization tools, visualizes the correct flood extent, but is pixelated and lacks photorealism.

<table>
<thead>
<tr>
<th></th>
<th>LPIPS (high res.)</th>
<th>LPIPS (low res.)</th>
<th>IoU (high res.)</th>
<th>IoU (low res.)</th>
<th>FVPS (high res.)</th>
<th>FVPS (low res.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GAN w/ phys. (ours)</td>
<td>0.265</td>
<td>0.283</td>
<td>0.502</td>
<td>0.365</td>
<td>0.533</td>
<td>0.408</td>
</tr>
<tr>
<td>GAN w/o phys.</td>
<td>0.293</td>
<td>0.293</td>
<td>0.226</td>
<td>0.226</td>
<td>0.275</td>
<td>0.275</td>
</tr>
<tr>
<td>VAEGAN w/ phys.</td>
<td>0.449</td>
<td>-</td>
<td>0.468</td>
<td>-</td>
<td>0.437</td>
<td>-</td>
</tr>
<tr>
<td>Handcrafted baseline</td>
<td>0.339</td>
<td>0.415</td>
<td>0.470</td>
<td>0.361</td>
<td>0.411</td>
<td>0.359</td>
</tr>
</tbody>
</table>

A GAN without physics information generates photorealistic but non physcially-consistent imagery (Figure X). The inaccurately modeled flood extent illustrates the physical inconsistency, and a low IoU of 0.226 over the test set further confirms it. Despite the photorealism, the physical inconsistency renders the model non-trustworthy for critical decision making, as confirmed by the low FVPS of 0.275. The model is the default Pix2PixHD (T.-C. Wang et al., 2018b), which uses only the pre-flood image and no flood mask as input.
A handcrafted baseline model generates physically-consistent but not photorealistic imagery (Figure X). Similar to common flood visualization tools (Climate Central, 2018), the handcrafted model overlays the flood mask input as a hand-picked flood brown onto the pre-flood image. Because typical storm surge models output flood masks at low resolution (30 m/px (NOAA National Weather Service National Hurricane Center Storm Surge Prediction Unit, 2020)), the handcrafted baseline generates pixelated, non-photorealistic imagery. Combining the high IoU of 0.361 and the poor LPIPS of 0.415 yields a low FVPS score of 0.359.

The proposed physics-informed GAN generates physically-consistent and photorealistic imagery. To create the physics-informed GAN, we trained Pix2PixHD (T.-C. Wang et al., 2018b) from scratch on our dataset (~7 hours on 8 V100 Google Cloud GPUs). This model learned to convert a pre-flood image and a flood mask into a photorealistic post-flood image.

The model outperformed all other models in FVPS (0.533). The learned image transformation “in-paints” the flood mask in the correct flood colors and displays an average flood height that does not cover structures (e.g., buildings and trees). While our model also outperforms the VAEGAN (BicycleGAN (Zhu, Zhang, et al., 2017)), the latter has the potential to create ensemble forecasts over flood impacts, such as the probability of destroyed buildings.
Figure 51. The proposed physics-informed GAN, (d), generates photorealistic and physically-consistent flood imagery from the inputs, (a, b), outperforming all other models, (e, f, g). The baseline GAN, pix2pixHD (e), in comparison, receives only a pre-flooding image and no physical input. The resulting image, (e), is fully-flooded, rendering the model untrustworthy for emergency response. The VAEGAN, BicycleGAN (f), creates error-prone imagery. A handcrafted baseline model (g), as used in common visualization tools, visualizes the correct flood extent, but is pixelated and lacks photorealism.
5.4.1. More scenarios

The model was trained and tested on data from Hurricane Florence (North Carolina, 2018) and Hurricane Harvey (Texas, 2017). Below, I include more images and highlight additional aspects of the model.

Figure 52. The physics-informed GAN turns pre-flood imagery (top row) into photorealistic and physically-consistent post-flood imagery (bottom row) for Hurricane Florence (left two columns) and for Hurricane Harvey (right two columns).

Figure 53. Our model sometimes smears structures such as streets, cars, and buildings.
Figure 54. The model learns that flooded vegetation looks greener than before flooding.

Figure 55. The model learns not to paint flooding elevated structures, such as trees and homes.
Figure 56. The model learns how to work with flooding around human structures. Note that the SLOSH model input, the segmentation map, is low-resolution – but nonetheless, the flooding around the highway looks realistic. Even given a low-resolution segmentation map, the model learns to generate quite realistic, high-resolution imagery.

5.5. Discussion

Our pipeline outperforms all baselines in the generation of physically-consistent and photorealistic imagery of coastal floods, paving the way for future advancements in generative models for climate change.

Our pipeline outperforms all baselines in the generation of physically-consistent and photorealistic imagery of coastal floods, paving the way for future advancements in generative models for extreme weather and climate change. As with most GANs, the computational intensity of training made it difficult to fine-tune
models on new data; improved transfer learning techniques could address this challenge. Furthermore, our
dataset only contained ~3,000 samples and skewed towards vegetation-filled satellite imagery; this data
limitation likely contributed to our model smearing human-built structures, such as streets and skyscrapers.
In addition, the dataset was generated by Maxar imagery, and preliminary results suggest that our model
does not generalize well to other data sources such as NAIP imagery (USDA-FSA-APFO Aerial
Photography Field Office, 2019). We attempted to overcome our data limitations using several state-of-the-art
augmentation techniques, but this work would benefit from more public sources of high-resolution
satellite imagery.

5.6. Future work

We have identified several directions for future work, including UI design (building a usable
interface for various stakeholders), transfer learning (using inputs from other satellite imagery
providers or generalizing to other areas and events), and interpretability (using network dissection
to understand which neurons are associated with which features).

Given our initial success with generating satellite imagery of future climate events, we believe the field is
ripe for more research. In particular, our work offers promising intersections with user interface design,
transfer learning, and interpretability, each of which could advance the state of the EIE.

5.6.1. User interface design

As decision support tools use increasingly sophisticated digital technologies, user experience design has
become a critical part of creating value for decision-makers. Creating a well-designed, functional user
experience for the Earth Intelligence Engine (EIE) could therefore be the difference between adoption and
neglect of the technology.

According to Blair-Erly and Zender, there are several dimensions to consider when making a user interface
(Blair-Erly & Zender, 2008). First, there is the content type, which ranges from scientific – clear, direct,
and accessible – to poetic – experiential, emotional, and interpretive. For decision-support, the EIE falls
on the scientific side of the spectrum, although an EIE adaptation for the general public could benefit from
a more poetic interface. Next, there is the content delivery strategy, including archetypes such as librarian,
instructor, speaker, and actor. For short-term disaster planning, an EIE user experience could function as a librarian, a reference that contributes to a large body of information. For long-term city-planning, however, the EIE could also adopt the role of speaker, as its evocative imagery may motivate decision-makers to plan more thoroughly for future flooding. Finally, the authors also distinguish between “hunter” users – those driven towards a target by a specific need – and “browser” users – those driven by curiosity. EIE users will likely include both hunters and browsers.

![Prototype Visualization](image)

**Figure 57.** *We have developed a prototype visualization. Users control a slider to compare pre- and post-flooding in the same image space. See the demo here: [http://trillium.tech/eie/](http://trillium.tech/eie/).*

Blair-Early and Zender also include ten interface design principles – such as creating clear starting and stopping points, feedback mechanisms, and landmarks – along with four general design principles: make the content obvious immediately, use visualizations for large data sets, make the interface engaging, and use visual metaphors to communicate new ideas. These principles should help guide the design of an Earth Intelligence interface.
In terms of the actual design process, I believe using adaptive design (Keen, 1980) can help address uncertainty surrounding usage of the EIE. As Keen writes, adaptive design may be needed for any of the following reasons: specifications for the system are unclear; users don’t know what they want until they see an initial version; the decision-support system will shape and inform users’ needs for additional functions; or the diversity of users makes standardization difficult. With the EIE, all of these concerns apply to varying extents.

Finally, the communication principles I discussed in Section 3.3.1 – adapt to your audience, maximize signal-to-noise ratio, and use effective redundancy – also apply to user experience and user interface design. Future research on the Earth Intelligence Engine could therefore center on building an effective interface for various stakeholders, including NOAA, city planners, and the military.

5.6.2. Transfer learning

Deep learning often requires huge amounts of training data, which can be expensive, time-consuming, or simply unfeasible to curate. To address this challenge, researchers have developed transfer learning: using knowledge learned in one domain to solve problems in another (Zhuang et al., 2019). For the Earth Intelligence Engine, transfer learning could not only allow us to use inputs from other satellite imagery providers, but also generalize to areas and events that we have not yet trained on.

Already, researchers have used transfer learning to go from object classification to agricultural classification (Chew et al., 2020), from Argentine soybean harvest prediction to Brazilian soybean harvest prediction (A. X. Wang, Tran, Desai, Lobell, & Ermon, 2018), and from object classification to nightlight detection in satellite imagery for poverty prediction (Jean et al., 2016).

A typical approach is starting from a pretrained network – where early layers are already trained to look for edges and other basic features – and then re-training only the later layers of the network on the new data source (A. X. Wang et al., 2018). According to (Y. Wang et al., 2018), starting from a pre-trained model diminishes the required amount of training images by a factor ranging from two to five. They also note that
transferring the GAN discriminator is actually more important than transferring the generator – although ideally, both are transferred.

Given the wide array of remote sensing imagery (Planet, Landsat, and others) and flood models (SLOSH, ADCIRC, and others) – all with different resolutions – the Earth Intelligence Engine would be substantially more useful if it were not reliant on DigitalGlobe and SLOSH alone. Transfer learning could help extend the capabilities of the model, such that users could use a wider variety of inputs. Transfer learning could also be used to generate satellite imagery on areas for which we have less data, extending our work beyond the US East Coast. We could even retrain part of our model on imagery from US military bases around the world, e.g. in the Maldives, and then – assuming we could run flood models for other parts of the world – generate images of future flooding for areas that would not otherwise have access to this kind of data. Finally, as a particularly ambitious goal, transfer learning could be used to help generate satellite imagery of other weather events. Of course, given the visual gap between flooding and other disasters, this should only be attempted once other transfer learning efforts have proven successful.

5.6.3. Interpretability

“Interpretability” has become a buzzword in the machine learning community, but there remain many open problems. One challenge, of course, is that AI researchers have not yet agreed upon a definition of interpretability (Lipton, 2016). “Transparency,” “simulatability,” and “explainability” are all related but distinct concepts, but there is no consensus as to which qualities matter in which contexts.

Nonetheless, in the area of generative models, researchers have made several attempts at making GANs more intuitive, trustworthy, or interpretable. In one paper (Voynov & Babenko, 2020b), authors “automate” the exploration of a GAN’s latent space. In particular, their approach finds directions in the latent space that correspond to distinct image transformations, such as blurring the background, tilting an object, or changing a skin tone. In another paper (Voynov & Babenko, 2020a), the authors design the GAN for unsupervised interpretability: rather than using random Gaussian vectors as inputs, the GAN takes an input that represents a specific path through the GAN’s generator. Varying the input therefore corresponds to varying the path taken through the generator, offering insight into which layers are associated with which
qualities in the output image. While the first approach could be applied to the EIE, the second would require training a new GAN from scratch.

One particularly interesting approach for the EIE is called “Network dissection” (Bau, Zhou, Khosla, Oliva, & Csail, 2017). This approach “identifies hidden units’ semantics for any given CNN [convolutional neural network], then aligns them with human-interpretable concepts.” In other words, network dissection identifies which neurons are responsible for which class in the output image, outputting an intersection over union score that represents the accuracy of unit \( k \) for detecting concept \( c \). By varying the weight of unit \( k \), then, users can change the classes in the output image. Interestingly, the GAN does not indiscriminately add features; rather, it has “opinions” about which semantic features belong where, so users are able to add doors to building, but they cannot add doors to the open sky. The authors publicized this functionality as GANPaint, where users can “paint” clouds, trees, and other semantic features into GAN-generated images.

For the EIE, future work could apply the concept of network dissection to create a GANPaint for satellite imagery: a tool where users could “paint” desert, water, or other Earth classes onto satellite images to visualize environmental change. The first step would be developing a land use or land cover segmentation model, such as the one developed by Caleb Robinson, et al. This segmentation model would enable the process of GAN dissection; without it, there’s no way to identify semantic concepts within satellite imagery. Then, users would have to search the GAN’s latent space to create the closest version possible given an input image, as the GAN can only manipulate images that it created. Finally, users could change weights of the GAN, thereby changing the image. In the long term, the “painting” could be guided by climate models, rather than people.

5.7. Conclusion

Chapter five introduced technical background and summarized research results for the Earth Intelligence Engine. We build a GAN, a neural network that can generate images, to ease communication between experts and decision-makers for flooding. In particular, our GAN combines a pre-flood image and a physics-based input to create physically-consistent, photorealistic satellite imagery of future flooding. Training data comes from the xBD data set (for satellite images) and NOAA’s SLOSH model (for flood
predictions). According to our Flood Visualization Plausibility Score (FVPS), which accounts for both photorealism and physical consistency, our GAN outperforms other GANs and a handcrafted baseline. Furthermore, our GAN learns that flooded vegetation looks greener and that elevated structures don’t get flooded. Our GAN does sometimes smear buildings and other human-made structures, but it’s also able to produce photorealistic images even given a low-resolution flood prediction. Future research should consider user interface design, transfer learning, and interpretability. In the next and final chapter, I conclude with a summary of this document, along with providing perspectives on the future.
6. Conclusion

In this thesis, I develop EarthDNA Ambassadors, a community that ripens the issue of climate change, and initialize the Earth Intelligence Engine, a visualization framework that bridges the gap between machine learning, climate models, and decision-makers.

6.1. Summary

First, chapter two reviews the scientific, media, and political dimensions of climate change. Although scientists have accumulated decades of evidence for anthropogenic climate change and its harmful consequences, broad systemic challenges have prevented Americans from taking the bold steps needed to tackle the issue. These challenges include the inherent complexity of climate change, along with incentive structures and identity systems that permeate the media and political landscapes of the US. As a result, America lags behind Europe in addressing climate change, with even the most climate-friendly American administrations largely unable to muster a sufficient response.

Chapter three provides context on community organizing, climate education, and leadership. Organizing is “leadership that enables people to turn the resources they have into the power they need to make the change they want.” Organizers build relationships, tell stories, create structure, devise strategy, and take action, balancing realism and irreverence in their approach. Although young people make ideal allies for generating productive disequilibrium around climate, the education sector does not yet have the capacity to teach them effectively about climate change. Educators must embrace both technical and adaptive work to close the gap between aspirations and reality. In both the climate and education sphere, leadership is required to help communities move from the past into the future. Leaders need negotiation, communication, and storytelling skills, along with a strong sense of self-awareness – but most importantly, leadership must be exercised from a place of love.

Combining community organizing, climate education, and leadership, chapter four reviews the results of EarthDNA Ambassadors, an organization that connects leaders, empowers students, and engages the world on climate change. Team Connect recruited dozens of Ambassadors, providing a valuable community for
climate leaders to support each other personally and professionally. Team Empower delivered EarthDNA’s leadership training program, a ten-week curriculum that offers valuable perspectives on climate change, improves Ambassadors’ skills at negotiation and communication, and cultivates growth mindset. Team Engage delivered EarthDNA’s Climate 101 workshop, improving climate literacy and behaviors. Climate 101 generates productive disequilibrium around climate change, creating a “privileged moment” in which participants are more likely to increase their involvement in climate activism. More resources related to EarthDNA Ambassadors are below:

- **Climate 101 video**
- **Leadership development syllabus**
- **EarthDNA Ambassadors website**
- **EU Climate Science from Space Conference: Youth Engagement Panel**

Chapter five introduces technical background and summarizes research results for the Earth Intelligence Engine. We build a generative model to ease communication between experts and decision-makers for flooding. In particular, our GAN combines a pre-flood image and a physics-based input to create physically-consistent, photorealistic satellite imagery of future flooding. Satellite images for training come from xBD data set and flood predictions for training come from NOAA’s SLOSH model. Our Flood Visualization Plausibility Score (FVPS), which accounts for both photorealism and physical consistency, shows that our GAN outperforms other GANs, as well as a handcrafted baseline. Although our GAN sometimes smears human-made structures, it also learns that flooded vegetation looks greener and that elevated structures don’t get flooded. As a result, it’s able to produce photorealistic images even given a low-resolution flood prediction. A list of related work by the EIE team is below:

- **Physically-Consistent Generative Adversarial Networks for Coastal Flood Visualization**
- **Graph Neural Networks for Improved El Niño Forecasting**
- **Uncertainty-Aware Physics-Informed Neural Networks for Parametrizations in Ocean Modeling**
- **SEVIR: A Storm Event Imagery Dataset for Deep Learning Applications in Radar and Satellite Meteorology**
- **AI 101 (slides and notes)**
6.2. Discussion

EarthDNA Ambassadors occupy a valuable role in the climate movement. As one Ambassador writes, “It is energising to interact with others that share similar values,” and EarthDNA provides a strong holding environment to deal with the intense emotions of climate change: grief, anxiety, and fear. Furthermore, Climate 101 fills an important gap in climate education, as it offers a perspective on climate change that extends beyond scientific factors. It’s engaging, broad, tangible, and hopeful – and although one workshop cannot provide the emotional and somatic development needed for a full reevaluation of value hierarchies, I believe it can stimulate enough thought and discomfort that participants become more open to change in future interventions. Finally, EarthDNA’s Ambassador training provides a unique opportunity for climate leaders to engage in personal growth. The trainings, curated from materials at MIT and the Harvard Kennedy School, are designed not just to confer skills, but also to build participants’ capacity as leaders and as people – an important contribution to a strong climate movement. By offering interdisciplinary educational materials and providing robust leadership development, EarthDNA Ambassadors distinguishes itself from the Sunrise Movement, Climate Reality Project, and other organizations in the climate space.

Similarly, the Earth Intelligence Engine fills a crucial gap in flood risk communications and helps further the collaboration between climate experts and machine learning researchers. An Air Force Weather Officer described the need as follows: “Imagine a room full of people preparing for a flood, either short-term or long-term. The mayor’s there – or maybe it’s the commander of a military base, or the governor – along with emergency responders, medical personnel, etc. Someone has to convey to all those people as quickly and as clearly as possible what’s likely to happen” (Radovan, de Suarez, Loftis, & Cohen, 2020). Current tools for flood risk visualizations are insufficient for this task, because they are either too technical and dense or too low-level. The EIE’s flood visualizations, however, can convey risks in a way that is both informative and meaningful. Moreover, by creating a baseline for generating satellite imagery of future weather and climate events, we aim to inspire similar projects for all kinds of Earth-related generative models.
6.3. Future work

In the future, both EarthDNA and the Earth Intelligence Engine offer exciting prospects for development. EarthDNA aims to grow its Ambassador pool from 30 to 100 people in 2021, and to prepare itself for continued growth in 2022, leading to wider reach and better opportunities for coalition-building. Follow-up work should survey people’s growth after several months of being in the organization. In the meantime – and in the spirit of developing a robust community organization – we aspire to become more diverse and more playful in our work, both of which will generate more creativity in our problem-solving. The Ambassadors remain very much in the process of capacity building, and we are in a state of constant evaluation to determine objectives, strategies, and structures. In other words, we are working through our own, internal adaptive challenges: it’s not yet clear whether we’ll be a development space for other community organizers or whether we ourselves will engage in conflict with entrenched power structures. A successful EarthDNA Ambassadors organization could serve as a hub for training climate leaders around the world, or it may develop the political muscle necessary to influence policy – or it may offer some combination of the two. As with any adaptive challenge, it’s hard to know at the outset how the issue will be resolved.

Of course, although EarthDNA is valuable for connecting leaders, empowering students, and engaging the world, it acts as a mere stopgap for the broader issue of climate education. Science teachers should teach the science of climate change. But limiting climate discussions to the science classroom is like reading only halfway through a book: students aren’t hearing the full story, and as a result, they’re unable to connect climate to other high-impact concerns. By engaging in difficult conversations about climate that challenge people’s values – and by leaning on inter-generational learning – we can create productive disequilibrium around climate change for students, families, and lawmakers across the country. This is the best way to overcome ingrained biases, corporate disinformation, and decades of ineffectual science communication.

As for the EIE, we hope to deploy our flood visualization model with NOAA – integrating flood forecasts with aerial imagery along the entire US East Coast – and then to expand to other areas and events. Our proposed pipeline can generalize in time, space, and type of event, so we envision a global visualization tool for climate impacts. By changing the input data, future work can visualize impacts of other well-modeled, climate-attributed events, including arctic sea ice melt, wildfires, or droughts. Non-binary climate impacts,
such as inundation height, or drought strength can be generated by replacing the binary flood mask with continuous model predictions. Opportunities are abundant for further work in visualizing our changing Earth, and given its potential impact for both climate mitigation and adaptation, we encourage the remote sensing and machine learning communities to take up the challenge of generating and applying more data and more models for the creation of an “EarthDNA Embassy.” These visualizations could seed the creation of other similar work, easing communication between experts and decision-makers and reducing a key source of friction in climate adaptation.

On the broader question of climate change – not just its technical components, but its political and social aspects as well – visualizations of Earth could also support social shifts. Future work could include economic analysis, so that our visualizations are accompanied by a specific dollar amount (or range) of damage associated with the image. Our visual model – or models like it – could then be implemented in a pipeline on a district-by-district basis, showing policymakers what will happen to their district under different climate scenarios; showing mayors what will happen to their cities under different planning scenarios; and showing businesses what will happen to their assets under different investment scenarios.

Climate change requires a full-scale mobilization. That means both technical and adaptive work: new technologies and policies, yes, but also new ways of seeing ourselves and understanding our place in the world. Of course, this means that recovering from our climate crisis hinges on progress in other areas: inequity, polarization, institutional backsliding. While this dependency may seem daunting, it also presents an opportunity. Climate change demands that we address many of the world’s most pressing issues – and it will take all of us to succeed.
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https://doi.org/10.1073/pnas.1914085117


Drummond, C., & Fischhoff, B. (2017). Individuals with greater science literacy and education have more polarized beliefs on controversial science topics. Proceedings of the National Academy of Sciences of the United States of America, 114(36), 9587–9592. https://doi.org/10.1073/pnas.1704882114


Guldberg, O., Jacob, D., Taylor, M., Bindi, M., Brown, S., Camilloni, I., ... Zhou, G. (n.d.). Impacts of 1.5°C Global Warming on Natural and Human Systems.


Landscapes from Environmental Conditions Using Generative Networks.


U.S. Climate Extremes Index (CEI): Graph | Extremes | National Centers for Environmental
Public Engagement for Public Education (pp. 139–172).
https://doi.org/10.1515/9780804776387-008


Appendix A: EarthDNA Climate 101 Workshop

We Need to Talk.
By EarthDNA

MIT Portugal

The Truth
The Consequences
The Myths
The Future
Video source: Prince Ea, *His Epic Message Will Make You Want to Save the World* | Film4Climate. National Geographic, 2017. [https://www.youtube.com/watch?v=B-nEYsyRLYo](https://www.youtube.com/watch?v=B-nEYsyRLYo)

In 1896, a scientist discovered the *greenhouse effect*: some gases in our atmosphere trap heat.

More info: [https://climate.nasa.gov/causes/](https://climate.nasa.gov/causes/)
We emit these greenhouse gases by burning fossil fuels for transportation and electricity.


Image sources:
- [https://en.wikipedia.org/wiki/Air_conditioning](https://en.wikipedia.org/wiki/Air_conditioning)

As we burn fossil fuels like oil, gas, and coal, greenhouse gas concentrations rise.

More info: [https://climate.nasa.gov/vital-signs/carbon-dioxide/](https://climate.nasa.gov/vital-signs/carbon-dioxide/)
Data source: Scripps Oceanographic Institute.
Image source: [insideclimatenews.org/content/chart-atmospheric-co2-levels-have-been-rising](https://insideclimatenews.org/content/chart-atmospheric-co2-levels-have-been-rising)
Greenhouse gases have spiked since industrialization.

More info: https://climate.nasa.gov/vital-signs/carbon-dioxide/
Data source: Reconstruction from ice cores. Credit: NOAA
Image source: https://climate.nasa.gov/vital-signs/carbon-dioxide/

As humans emit more greenhouse gases, our atmosphere traps more heat, and the Earth warms.

0.82°C (or, 1.5°F)

More info: https://svs.gsfc.nasa.gov/31028

**Camp fire:**

**Midwestern Flooding:**

**East coast hurricanes:**
Heatwaves, floods, and other disasters are becoming more frequent.

More info: [https://climate.nasa.gov/effects/](https://climate.nasa.gov/effects/)
Source: EMDAT (2019) OFDA/CRED International Disaster Database, Universite Catholique de Louvain.
Image source: [https://ourworldindata.org/natural-disasters](https://ourworldindata.org/natural-disasters)

Cities must spend your parents’ tax money on climate adaptations instead of schools, transit, and hospitals.

More info: [https://nca2018.globalchange.gov/chapter/18/](https://nca2018.globalchange.gov/chapter/18/)
Image sources:
- [https://en.wikipedia.org/wiki/Primary_education_in_the_United_States](https://en.wikipedia.org/wiki/Primary_education_in_the_United_States)
Unusual weather also affects food. By 2030, a drought could double the price of corn.*

*Even if you don’t eat corn, you might like chicken and fish, which are raised on corn feed. Or maybe you eat high fructose corn syrup in cereal or bread.

By stifling crop growth, climate change limits food access.

More info: [https://nca2018.globalchange.gov/chapter/10/](https://nca2018.globalchange.gov/chapter/10/)

Sources:

- T. Moss and L. V. J. Wholey, “Climate change linked to global rise in food prices,” Climate Change | Medill | Northwestern University. [Online].


Climate change also affects water. This woman migrated over 150 miles because of a drought.


Image source: National Geographic.
By 2050 the UN projects **200 million** environmental migrants.*

*People who leave their homes because of changes in the environment.

More info: [https://www.iom.int/migration-and-climate-change-0](https://www.iom.int/migration-and-climate-change-0)

In recent migrant crises, **thousands** of refugees created turmoil in Europe and America.
What happens when **millions** of people move North in search of food, water, and safety?

The US military refers to climate change as a “threat multiplier,” because it makes every bad situation worse.*

* The Pentagon has released reports about climate change under both Democratic and Republican administrations.


The current species extinction rate is 1,000 times higher than normal.

Image source: https://geneticliteracyproject.org/2016/05/18/science-news-release-media-miss-bee-extinction-reports/
We’re on track for one million species extinctions. Here’s what one looks like:


Video source: *The Last Northern White Rhinos* | *Years of Living Dangerously*. National Geographic, 2017. [https://www.youtube.com/watch?v=B-nEYsyRIYo](https://www.youtube.com/watch?v=B-nEYsyRIYo)

This is called the *tragedy of the commons*: when anyone can access a limited resource, it runs out.


Earth is a commons.

To resolve commons problems, we must set rules. This is called *politics*.


Protecting the most important commons, an inhabitable Earth, is political: we need rules.

But rules cost money. For example:

“If I can’t sell my products, because I emit carbon to make them... I lose money!”

No one wants rules limiting carbon. But especially not fossil fuel groups, who emit more than anyone.

The fossil fuel industry has known about climate change for decades.

Data source: UN Food and Agricultural Organization

More info: [https://exxonknew.org/](https://exxonknew.org/)
Image source: [https://insideclimatenews.org/content/exxon-science-vs-misinformation](https://insideclimatenews.org/content/exxon-science-vs-misinformation)
But fossil fuel companies spread climate myths to the public— including schools.


Source: https://climate.nasa.gov/scientific-consensus/
Video source: Climate Denial in the Classroom. The Years Project, 2018. https://www.youtube.com/watch?v=HXoAz6jNEG8

More info: https://insideclimatenews.org/content/Exxon-The-Road-Not-Taken
Fossil fuel companies know rules will hurt profits, so they spread myths about climate change.

More info: https://skepticalscience.com/misinformers.php

Climate change is real.
It’s happening because of us.
It already affects you.
It will only get worse.

We haven’t done anything, because fossil fuel companies have lied to us for decades.
We need to cut carbon emissions and use natural climate solutions.

Children like me are giving up their education to protest.

More info: https://www.drawdown.org/

Words give life to ideas. Ideas lead to change.

Your words matter.
It may feel awkward, but studies show teens are great at making parents care about climate change.

Be open, gentle, and honest. Try starting with “How do you feel about climate change?”


“This is what heaven must look like.”
– Mike Massimino, NASA Astronaut

It’s not too late to keep our paradise.
But we can’t do it without you.

Image source: Prince Ea, *His Epic Message Will Make You Want to Save the World* | Film4Climate. National Geographic, 2017. [https://www.youtube.com/watch?v=B-nEYsyRIYo](https://www.youtube.com/watch?v=B-nEYsyRIYo)
Appendix B: EarthDNA Ambassador Training Workbook
EarthDNA Ambassador Workbook
<table>
<thead>
<tr>
<th>Week</th>
<th>Workshop</th>
<th>Workshop</th>
<th>Reading List</th>
</tr>
</thead>
</table>
2. [What Is Organizing?](#) (Pgs. 1-3)  
3. [Discussing Global Warming](#)  
4. Abstract only: *Children can foster climate change concern* |
| 2    | Module A-3: Self-Awareness II - Leadership Purpose | Module A-4: Difficult Conversations I - Preparation | 1. [NASA](#): Familiarize yourself with Evidence, Causes, Effects, etc. on NASA's climate portal |
| 3    | Module A-5: Difficult Conversations II - Practice | Module B-1: Public Narrative I - Story of Self | 1. [National Climate Assessment](#): read the executive summary for your region and for a few other chapters of your choice |
| 4    | Module B-2: Public Narrative II - Story of Us | Module B-3: Public Narrative III - Story of Now | 1. Economics *chapter introductions* for 3, 4, 8, and 12  
2. [Cap-and-trade vs. Carbon tax](#) |
| 5    | Module B-4: Public Narrative IV - Linked Stories | Module B-5: Public Narrative V - Linked Stories | 1. [Summary of Thanks for the Feedback](#)  
Homework:  
Read [iDecisionGames](#) 67 Fish Pond Lane PDF for Module C-1 (~1 hr). (Do not discuss with reading group) |
| 6    | Module C-1: Negotiation I - Value Claiming | Module C-2: Negotiation II - Value Creation | 1. [Smart Alternatives to Lying](#)  
Homework:  
Read [iDG](#) New Recruit PDFs for Module C-2 (~20 mins) and Three-Party Coalition Emailed PDFs for Module C-3 (~ 30 mins). (Do not discuss with reading group) |
| 7    | Module C-3: Negotiation III - Building Power and Overcoming Barriers | Module C-4: Negotiation IV - HarborCo | 1. [Environmental Justice in the Twenty-First Century](#)  
Homework:  
Read [iDG](#) HarborCo PDFs (there are two) for Module C-4 (~1-1.5 hrs). (Do not discuss with reading group) |
| 8    | Module C-5: Negotiation V - HarborCo Debrief | Module D-1: Communication I - Introduction | 1. [A New Climate for Society](#)  
2. [The Greatest Scam in History](#) |
| 9  | **Module D-2:** Communication II - Planning | **Module D-3:** Communication III - Designing | 1. **Drawdown Quiz**  
2. **Drawdown Review** (Pgs. 12-15)  
3. **Solutions** (choose a few to read about)  
4. **Adaptive Leadership Summary** |
|----|---------------------------------|---------------------------------|--------------------------------------------------|
| 10 | **Module D-4:** Communication IV - Delivering | **Module D-5:** Graduation! | 1. **Anchoring Yourself**  
2. **Environmental Leadership** |
EarthDNA Ambassadors Training Mission

One day, the world will unite in climate action. Until then, EarthDNA connects leaders, empowers students, and engages communities to build this future. Through our 10-week leadership program, Ambassadors gain skills and knowledge that change the way they see and interact with the world. Ambassadors start with an intense focus on self-awareness, as leaders can achieve their goals only if they know what they want and why. From there, Ambassadors learn to tell stories that motivate action, negotiate agreements that advance their interests, and communicate messages that make an impact. By the end of 10 weeks, Ambassadors are equipped to join (or create) an EarthDNA sub-team based on their skills, interests, and passions. Because leadership development hinges upon Ambassadors giving each other feedback, attendance is required at all sessions.

Team Connect: The roots of our tree. Team Connect anchors us into the climate movement and draws in new participants to nourish our organization.

Team Empower: The trunk of our tree. Team Empower transforms newcomers into leaders that can promote our values and protect our interests.

Team Engage: The leaves of our tree. Team Engage shares our work with communities that do not typically interact with the climate movement.
Module Summaries

Module A: Self-awareness
Module One serves as the foundation for the rest of training. Ambassadors reflect on their experiences and behaviors, prompting them to make discoveries about what's important to them and why. They also learn the process of navigating difficult conversations: an early, but crucial example of applying self-awareness to real-world interactions. Ultimately, by inviting Ambassadors to coach each other in small groups, Module One cultivates the core leadership skills of empathy, listening, and introspection.

Module B: Public Narrative
In Module Two, Ambassadors learn to tell their personal stories in service of building a movement. Specifically, they develop a story of self to connect themselves to the audience; a story of us to connect the audience to each other; and a story of now to connect everyone to the present moment. This module builds Ambassadors’ capacity for storytelling and self-reflection. By the end of Module Two, Ambassadors not only gain deeper insight into their own values and experiences, but they also learn a storytelling process by which they can motivate audiences to act collectively and urgently.

Module C: Negotiation
We negotiate every day. Our coworkers, bosses, siblings, parents, friends, and enemies all seek behaviors from us, and likewise, we from them. How, then, can we advance our interests? Moreover, how can we balance assertiveness with empathy? This module offers interactive experience negotiating agreements, culminating with a multi-party, multi-issue negotiation. Ambassadors gain an understanding of negotiation basics, including value claiming, value creation, and the seven elements of negotiation. The sessions also include discussions of power and barriers in negotiation. Finally, students receive feedback from their peers to encourage personal reflection and growth. Ambassadors are required to create accounts with iDecisionGames to access negotiation simulations and debrief materials.

Module D: Communication
In the fourth and final module, Ambassadors learn to craft compelling speeches, papers, and graphics. The first workshop offers a broad overview, while the next three dive deep into planning, designing, and delivering a message. By the end, students feel empowered to organize and share their ideas to make an impact. The final workshop concludes EarthDNA Ambassador training with a celebration and next steps.

Reading Groups
Reading groups meet weekly to discuss A) What each person learned, B) Ideas that were interesting or noteworthy, and C) Discussion questions of the group’s choosing. Please come prepared with a discussion question for each session with your reading group.
Module A-1: Introduction

Guidelines for discussion:
Becoming a leader is becoming yourself. The self-exploration required for this journey, however, can take place only in a safe environment. Accordingly, EarthDNA strives for a welcoming, vibrant community, and Ambassadors are expected to behave in accordance with the norms below:

- Show up on time, ready to engage.
- Assume best intentions.
- Be clear and candid when communicating.
- Assume you can learn from everyone.
- If you tend to speak up, leave space for others; if you tend to be quiet, speak up.

Please note that we will be sharing and exploring personal, sometimes painful, experiences. Others’ stories should be kept confidential, unless you receive explicit permission to discuss them.

Each session will conclude with the following debrief:
1. How does today’s workshop apply to leadership?
2. How does today’s workshop apply to climate change?
3. Appreciation break: have a few people share something they appreciated about someone else.

Finally, any language or activity that jeopardizes others’ participation in the EarthDNA community will result in expulsion.

Money:
While comparable programs typically charge thousands of dollars, EarthDNA asks only for Ambassadors to cover the $49-payment associated with iDecisionGames, which we use for negotiation simulations. Cost should never exclude anyone from joining, so please contact a member of your teaching team if this cost is prohibitive.

Time:
During leadership training, Ambassadors participate in two, 90-minute workshops weekly. Ambassadors also form reading groups, where they discuss texts weekly. Workshops occur at the same times each week. Reading groups are independent. Ambassadors-in-training spend 3 hours in workshops, 1 hour on reading, and 1 hour in a reading group each week.

Activity: Professional and Private Narratives

Goal of this activity: Explore our journeys and practice listening.

Speaker’s Role: Share your professional narrative, then share your personal narrative.

- Your professional narrative is what you’d say at a job interview, as you discuss how you ended up where you are now.
● Your personal narrative is what actually shaped your path. Sometimes it’s a childhood experience; sometimes it’s circumstances; and sometimes it’s just luck.

**Listener’s Role:** Listen.
- Turn off your filters.
- No judging, no problem-solving, no predicting.
- Just listen.

Then switch roles!

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**Key Takeaways:**
- **Priming is a useful tool for encouraging others to share.** By being open and vulnerable, we can create space for those around us to do the same.
- **Listening is critical.** We’ll return to this over and over again – not just in introductions, but for difficult conversations and negotiation.
- **Our paths don’t always make sense, and they’re almost certainly not planned in advance.**
Module A-2: Self-Awareness I - Crucible Stories

From True North and Finding Your True North

Crucible stories

“A crucible is a moment or time that was exceedingly difficult, transformative, and/or defining. A crucible can be triggered by events such as confronting a difficult situation at work, receiving critical feedback, or losing your job. Or it may result from a painful personal experience, such as divorce, illness, or the death of a loved one.”

“Your crucible tests you to the core of your being. It forces you to look at yourself, examine your character and your values in a new light, and come to grips with who you are. Viewed in retrospect, your crucible may become the defining experience in your life, even if you do not recognize it when you are in the middle of the experience… Passing through the crucible--or reframing it years later with the benefit of hindsight--you will see the world differently, and thus you will behave differently as well.”

Activity: Crucible Story

Goal: Discover how hardship has transformed and defined each of us.

Speaker’s Role:

- Reflect on your crucible story with the help of your partner. You don’t have to know your values ahead of time, but by exploring your crucible story – that time in your life that was most difficult or most transformative – you should be able identify six to eight core values.
  - These are the values you ignored or set aside during your crucible, exacerbating its difficulty; or they were values you leaned on to get through the crucible.

Listener’s Role:

- Ask questions with the intention of helping the speaker reflect on their experience.

Then switch roles!

When finished, write your core values here:
Activity: Three Questions

**Goal:** Practice listening, coaching, and self-reflection.

**Speaker’s Role:**
- Share a problem, challenge, or difficulty you’re currently facing.

**Listener’s Role:**
- Ask three questions – no more, no less – to help the speaker reflect on what they’ve shared.

**Key Takeaways:**
- *When listening, mind your filters:* I know that; I disagree; That won’t work; How can I use this?
- *Practice radical listening:* listen to help the speaker empty their heart – even if they’re wrong, hateful, or ignorant.
Module A-3: Self-Awareness II - Leadership Purpose

From True North and Finding Your True North

Activity: Reflection

**Goal:** Start self reflection for leadership statement.

Reflect on the following questions below then begin drafting your leadership statement.

1. If you were to disappear from your current job/role in life and someone else with equivalent skills were to take your place, what would people miss?

2. Magical moments that you experienced as a kid when you were lost in the pure joy of an activity before the world told you who or what you should or shouldn't be:

3. Things you love to do that will always be a part of who you are (skiing, singing, etc.):

4. If you had no limitations (no concerns about money, family, etc.), what would you do?

5. What was your most satisfying moment in the last year?

Draft leadership purpose statement:
Examples of leadership statements:

- Sir Richard Branson: "To have fun in [my] journey through life and learn from [my] mistakes."
- Elon Musk: "If something is important enough you should try, even if it will probably fail."
- Oprah Winfrey: "To be a teacher. And to be known for inspiring my students to be more than they thought they could be."

**Activity: Refine Leadership Purpose Statement**

**Goal:** Refine leadership purpose statements.

**Coacher:**
- Ask the person to share their answers to the reflection questions. Take notes as they speak, and write down questions that come to mind.
  - Ask “What” –
    - What makes this moment important?
    - What is valuable to you about this experience?
    - What do you appreciate about that activity?
- Ask them questions about their answers.
- Ask them if they see any common themes in their experiences.
- Ask them to share their first draft.
- Share what you’ve noticed. Make clear they’re welcome to incorporate your feedback or not.
- Remember our work on radical listening.

**Coachee:** Use this space to note feedback and thoughts from your partner. Edit the Leadership Purpose Statement accordingly.

Then switch roles!

Room for reflection:
Important for Next Time:
- For the next class, come prepared with a difficult conversation you’ve had recently that you’d like to analyze.

Key Takeaways:
- *Rules for Radicals:* “Most people do not accumulate a body of experience. Most people go through life undergoing a series of happenings, which pass through their systems undigested. Happenings become experiences when they are digested, when they are reflected on, related to general patterns, and synthesized.”
- Suggested exercise: Ask someone you trust, “How do I get in my own way?”
Module A-4: Difficult Conversations I

From Difficult Conversations

Five-Step Overview of Difficult Conversations

- **Step 1:** Prepare by walking through the three layers of a difficult conversation.
- **Step 2:** Check your purposes and decide whether to raise it.
- **Step 3:** Start from the third story.
- **Step 4:** Explore their story and yours.
- **Step 5:** Problem solve.

We’re just going to go through the first three steps in today’s session.

**Difficult Conversations Step 1**

Prepare by walking through the three layers of a difficult conversation

Every difficult conversation has three layers. These sub-conversations include:

“**What happened?**”, “**Emotions**”, “**Identities.**”

1. The **“What happened?”** conversation: The observations, interpretations, and conclusions each of us made, along with our past experiences and assumed rules.
   a. Where does your story come from: observations/interpretations/conclusions, past experiences, assumed rules? Theirs?
   b. What impact has this situation had on you? What might their intentions have been? How about vice versa?
   c. What have you each contributed to the problem?

2. The **“Emotions”** conversation: The way the conversation makes each of us feel, along with our “emotional footprints” – which emotions are we comfortable expressing, and which not?
   a. How did you feel, how did they feel, and how did you each express your emotions?
   b. Explore your emotional footprint, and the bundle of emotions you experience.

3. The **“Identities”** conversation: The story we tell ourselves about ourselves, and how part of it might be at stake in this conversation.
   a. “I see myself as [good, competent, worthy of love, etc.]” or “I fear I am [selfish, slow, etc.]”.
   b. What’s at stake for you about you? What do you need to accept to be better grounded?
c. Cultivate a robust identity by using complex identity labels. “I don’t lie” is much more brittle than “I do my best to tell the truth, and sometimes that’s not possible.”

d. What’s at stake for them about themselves? What can you affirm about them to make them feel heard and valued and to protect their sense of self?

For all of these, the “And” stance applies – multiple things can be true at once.

Step 1 Example:

<table>
<thead>
<tr>
<th>“What happened?”</th>
<th>“Emotions”</th>
<th>“Identities”</th>
</tr>
</thead>
<tbody>
<tr>
<td>I can have a positive intention and create a negative impact.</td>
<td>I can feel angry and grateful and you can feel sad and frustrated.</td>
<td>I can do my best to be good and sometimes act selfishly. I can do my best to be competent and sometimes make mistakes.</td>
</tr>
</tbody>
</table>

Activity: Difficult Conversations Step 1

Objective: With a partner, walk through a difficult conversation using the “three sub-conversations” lens of Step 1 - keeping in mind the “And” stance.

Room for reflection:

Difficult Conversations Step 2

*Check your purposes and decide whether to raise it.*

Delivering a hard message is like throwing a hand grenade. You can throw it gently or you can coat it in sugar, but it will still blow up.

1. Purposes:
   a. What do you hope to accomplish by having this conversation?
   b. Is a conversation the best way to achieve it?
   c. Shift your stance to support learning, sharing, and problem-solving.
2. Deciding:
   a. Is this the best way to address the issue and achieve your purposes?
   b. How can you shift from message delivery to a learning stance?

Activity: Difficult Conversations Step 2

Objective: With a partner, continue walking through the difficult conversation using Step 2.

Room for reflection:

Difficult Conversations Step 3

Start from the third story.

Start the conversation by initiating from the third story.

1. Describe the problem as the difference between your stories.
   a. Include both viewpoints as a legitimate part of the discussion.
   b. What would be an objective description of the situation? This is the “third story”.
2. Share your purposes for having conversation.
3. Invite them to join you as a partner in sorting out the situation together.

Activity: Difficult Conversations Step 3

Objective: With a partner, continue walking through the difficult conversation using Step 3.

Room for reflection:
Key Takeaways:

- Keep in mind the “and” stance – multiple things can be true at once.
- When bringing up a difficult conversation, start from the “Third Story”.

Module A-5: Difficult Conversations II

From Difficult Conversations

Continue Difficult Conversations starting with Step 4.

Difficult Conversations Step 4

Explore their story and yours.

Explore and listen to each other's stories.

1. Listen to understand their perspective on what happened.
   a. Ask questions and paraphrase to see if you've got it.
   b. Acknowledge the feelings behind the argument and accusations.
   c. Unravel how the two of you got to this place.
2. Share your own viewpoint, your past experiences, intentions, feelings.
3. Throughout the conversation, reframe their comments!
   a. Truth → Different stories
   b. Blame → Contribution
   c. Accusation → Intentions and impacts
   d. Judgments → Feelings

Step 4 examples:

<table>
<thead>
<tr>
<th>Reframe…</th>
<th>To…</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Truth:</strong></td>
<td><strong>Different stories:</strong></td>
</tr>
<tr>
<td>“Climate scientists are just a bunch of liars.”</td>
<td>“Hm… Can you tell more about why you feel that way?”</td>
</tr>
<tr>
<td><strong>Blame:</strong></td>
<td><strong>Contribution:</strong></td>
</tr>
<tr>
<td>“This is all your fault.”</td>
<td>“I agree that I contributed, and I’m sorry. But I think we’ve both contributed, and I’d like to talk about it.”</td>
</tr>
<tr>
<td><strong>Accusation:</strong></td>
<td><strong>Intentions and impacts:</strong></td>
</tr>
<tr>
<td>“You did that on purpose!”</td>
<td>“I can tell you’re angry. My intention was not to upset you, even though I acknowledge that was the impact.”</td>
</tr>
<tr>
<td><strong>Judgment:</strong></td>
<td><strong>Feelings:</strong></td>
</tr>
<tr>
<td>“You just believe anything you hear, don’t you.”</td>
<td>“I know this issue is important to you, and I can see you’re frustrated.”</td>
</tr>
</tbody>
</table>
Activity: Difficult Conversations Step 4

Objective: With a partner, walking through a difficult climate conversation using Step 4.

Room for reflection:

Difficult Conversations Step 5

Problem solve.

Problem solve through difficult conversation.

1. Invent options that meet each side’s most important concerns.
2. Look to standards for what should happen. Keep in mind the standard of mutual caretaking; relationships that always go one way rarely last.
3. Talk about how to keep communication open as you go forward.

Important for Next Time:
- Beginning of Module B: Storytelling
- Optional prep: If you’d like to prep/brainstorm for storytelling, feel free to read Pgs. 4-11 in the Organizer’s Handbook. (You’ll also have time to read it during the next workshop).

Key Takeaway:
- Reframe comments and problem solve.
- Suggested exercise: Practice listening and reframing in a difficult conversation you’re having.
Module B-1: Public Narrative I - Story of Self

From material by Marshall Ganz

Read Pgs. 4-11 of the Organizer’s Handbook

The Public Narrative framework is made up of three components: a Story of Self, a Story of Us, and a Story of Now. A public narrative consists of three distinct stories that are threaded together by a common value.

- A **Story of Self** communicates the values that have called you to leadership.
- A **Story of Us** communicates the values shared by those in action.
- A **Story of Now** communicates an urgent challenge to those values that demand action now.

Watch an example with class.

Room for reflection:

**Activity: Drafting Story of Self**

**Goal:** Begin reflecting and drafting your Story of Self.
Reading:
- Read Pg. 12 of the Organizer’s Handbook, then skip to Pg. 42 to develop your Story of Self. Summaries are provided below.

Reflecting and Drafting:
- Reflect and brainstorm with questions and tables below from Pg. 42 and begin drafting your Story of Self.

**Story of Self**

*Summary of Pg. 12 of Organizer’s Handbook*

A **Story of Self** communicates the values that have called you to leadership.

1. Why we tell it: To connect ourselves to our audience.
2. What we say: A story that answers, “Why me?”
3. How we structure it: A challenge, a choice, and an outcome.

We construct our stories of self around **“choice points”** – moments when we faced a challenge, made a choice, experienced an outcome, and learned a lesson.

Example: A personal experience that taught the value of compassion.

**Reflection** (from Pg. 42 of Organizer’s Handbook):

1. Why am I called to lead in the climate movement? Note that this may have nothing to do with the environment; climate change can be an issue of justice, of responsibility, of compassion, etc. Who taught me this value? How?

2. Why did I decide to tackle this specific injustice or problem?

3. What values move me to act? Have these values always been important to me? If not, when did that change? When did I learn that value? How might these values inspire others to similar action?
4. What stories can I tell from my own life about specific people or events that would show, rather than tell, how I learned or acted on those values?

**Brainstorming** (from Pg. 42 of *Organizer’s Handbook*):
Use the table below to dig deeper on who you are and why you’re here. Write down thoughts or draw pictures to illustrate your responses.

<table>
<thead>
<tr>
<th>Where you come from</th>
<th>Who you are</th>
<th>How you got involved</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Where were you born and where did you grow up?</td>
<td>- What are you passionate about (interests, talents, hobbies)?</td>
<td>- Are there people or significant experiences that stick out for you (social movement leaders, role models, books or knowledge) that spurred you into taking action for the first time?</td>
</tr>
<tr>
<td>- Are there people that made an impact on you while growing up (family members, community members, role models, friends)?</td>
<td>- Are there significant experiences that have had an impact on your choices (school, travel, work, family, or partners)?</td>
<td>- What was your first experience of getting involved in organizing (volunteering in your community, supporting an organization, voting, attending a rally or protest)?</td>
</tr>
<tr>
<td>- Are there significant childhood experiences that stick out for you (early memories, coming-of-age experiences)?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Brainstorming (from Pg. 42 of *Organizer’s Handbook*):

Next, based on your reflection, use the table below to write out the details of one choice point – a specific experience when you faced a challenge, made a choice, experienced an outcome, and learned a lesson.

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Choice</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Why did you feel it was a challenge? What was so challenging about it?</td>
<td>- Why did you make the choice you made? How did it feel?</td>
<td>- How did the outcome feel and why? What did it teach you?</td>
</tr>
</tbody>
</table>
Draft an outline of your Story of Self below:

Note: As you write your Story of Self, do not write a script. Rather, write an outline, which allows for organic delivery.

<table>
<thead>
<tr>
<th>Main value: __________________________.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Challenge:</td>
</tr>
<tr>
<td>----------------------------------------</td>
</tr>
<tr>
<td>Choice:</td>
</tr>
<tr>
<td>----------------------------------------</td>
</tr>
<tr>
<td>Outcome:</td>
</tr>
<tr>
<td>----------------------------------------</td>
</tr>
<tr>
<td>Sensory details:</td>
</tr>
</tbody>
</table>

Important for Next Time:
- Refine Story of Self and start Story of Us.
- Optional prep: If you’d like to prep/brainstorm for the Story of Us, feel free to read Pg. 13 in the Organizer’s Handbook. (You’ll also have time to read it during the next workshop).

Key Takeaways:
- A public narrative consists of three distinct stories that are threaded together by a common value.
  - A Story of Self communicates the values that have called you to leadership.
  - A Story of Us communicates the values shared by those in action.
  - A Story of Now communicates an urgent challenge to those values that demand action now.
Module B-2: Public Narrative II - Story of Us

From material by Marshall Ganz

Activity: Coaching Story of Self

**Goal:** Practice coaching and refine Story of Self.

**Coacher:**
- Coach your partner’s Story of Self using the Coaching excerpt below.

**Coachee:**
- Take notes and revise your Story of Self.

Then switch roles!

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Coaching

*Excerpt taken from Pg. 46 of the Organizer’s Handbook*

**Step 1: Ask questions.**

Start by asking:
- *How did that go for you? How did you feel telling your story?*
- *If you were to tell it again, would you change anything in the telling? If yes, what would you do differently?*

Then, note some of your first impressions and give them space to speak to what you noticed.
- *I noticed you did ____ or made this decision in telling your story, why did you do that?*
- *You said ____ in telling your story, what did you mean by that?*

**Step 2: Pay attention.**

A. **Challenge, choice, outcome.**

- What were the specific challenges the storyteller faced?
- Did the storyteller paint a clear picture of those challenges?
- Was there a clear choice made in response to the challenge(s)?
- What was the outcome that resulted from the choice(s)?
  - *When you described _____, I got a clear picture of the challenge.*
  - *I understood the challenge to be _____ and the choice to be ____. Is that what you intended?*
  - *How would you describe the outcome of your choice? I heard ____ or learned ____, is that what you intended?*

B. **Values**

- Could you identify the storyteller’s values and where they come from? Did you hear the storyteller voice or describe certain emotions? How did the story make you feel?
  - It’s clear from your story that you value ____.
● Your description of that value / emotion resonated with me because...

C. Details & Setting.
- What were the sections of the story that had especially vivid details? What did these descriptions do or how did they make you feel?
  ● Your description of detail / image / feeling helped me identify with your experiences because...

Step 3: Tell them what you’ll remember
Tell the storyteller what stood out for you or resonated with you, and what you will remember.
  ● Your description of detail / image / feeling stood out for me, because…
  ● The story hooked me at ____ point, because...

Coachee: Use this space to note feedback on your Story of Self from your partner. Edit the story accordingly.

Activity: Drafting Story of Us

Goal: Begin reflecting and drafting your Story of Us.

Reading:
- Read Pg. 13 of the Organizer’s Handbook, then skip to Pg. 43 to develop your Story of Us. Summaries are provided below.

Reflecting and Drafting:
- Reflect and brainstorm with questions and tables below from Pg. 43 and begin drafting your Story of Us.

Story of Us

Summary of Pg. 13 of Organizer’s Handbook

A Story of Us communicates the values shared by those in action.

1. Why we tell it: To connect the audience to each other – this means you must have a clear audience.
2. What we say: A story that answers, “Why us? Why can we act for climate change? What is the value that binds us as a community?” This should be the same value as the one in your Story of Self.

3. How we structure it: a challenge, a choice, and an outcome that we have all experienced, showing how that value is important to our community.

Example: Religious and national holidays (e.g. Independence Day in the US honors the challenge of tyranny, the choice of war, and the outcome of liberty. It celebrates the values of freedom, courage, action, solidarity – and, of course, independence.)

Reflection (from Pg. 43 of Organizer’s Handbook):

1. What values do you share with this community? (note: community here is the ‘us’ in your story)

2. What experiences have had the greatest impact on this community? What challenges has it faced?

3. What change does this community hope for and why?
**Brainstorming** (from Pg. 43 of *Organizer’s Handbook*):
Use the table below to reflect on another choice point but this time, for your community.

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Choice</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>- What was the challenge we faced? What’s the root of that challenge?</td>
<td>- What specific choice did we make? What action did we take?</td>
<td>- What happened as a result of our choice? What hope can it give us?</td>
</tr>
</tbody>
</table>

**Draft an outline of your Story of Us below:**

Tell the story of how “we” (your audience) embody the value in your story of self.

- Self: “I’m inspired to fight for climate action, because I believe in the value of ____.”
- Us: “But we all believe in the value of ___. Remember that time that we as a group faced a challenge, made a choice, and lived with an outcome? That shows that all of us value ___.”

*Note: as you write your Story of Us, do not write a script. Rather, write an outline, which allows for organic delivery.*

**Main value** (should be the same value from your Story of Self): _________________.

Challenge:  

Choice:
Important for Next Time:

- We will refine our Story of Us and start our Story of Now.
- Optional prep: If you’d like to prep/brainstorm for Story of Now, feel free to read Pgs. 13-14 in the Organizer’s Handbook. (You’ll also have time to read it during the next workshop).
Module B-3: Public Narrative III - Story of Now

From material by Marshall Ganz

Activity: Coaching Story of Us

**Goal:** Practice coaching and refine Story of Us.

**Coacher:**
- Coach your partner’s Story of Us using the Coaching excerpt summarized in the module above on Workbook Pg. 24.

**Coachee:**
- Take notes and revise your Story of Us.

Then switch roles!

Coachee: Use this space to note feedback on your Story of Us from your partner. Edit the story accordingly.

Activity: Drafting Story of Now

**Goal:** Begin reflecting and drafting your Story of Now.

**Reading:**
- Read Pg. 13 of the Organizer’s Handbook, then skip to Pg. 44 to develop your Story of Now. Summaries are provided below.

**Reflecting and Drafting:**
- Reflect on the questions below and begin drafting your Story of Now.

**Story of Now**

*Summary of Pg. 13 of Organizer’s Handbook*

A **Story of Now** communicates an urgent challenge to those values that demand action now.

1. Why we tell it: To connect us all to the present moment, replacing action inhibitors (inertia, apathy, fear, isolation, self-doubt) with action motivators (urgency, anger, hope, solidarity, and you-can-make-a-difference).
2. What we say: A story that answers, “Why now? Why is now the right time for us to take action – to live up to our shared values?”

3. How we structure it: A challenge, a choice, and an outcome – but it’s a challenge (or opportunity) that we currently face, a choice we have before us, and an outcome if we make the right choice.

Example: “Right now, our value of ___ is under threat. We can choose to do nothing, or we can choose to act. If we take action, imagine the beautiful outcome. Will you join me?” Of course, you’d have to fill in the specifics of the challenge, choice, and outcome.

Reflection (from Pg. 44 of Organizer’s Handbook):

1. What is the urgent challenge your community faces?

2. What change does this community hope for and why? What would the future look like if this change is made? What would the future look like if the change isn’t made? (note: here, you’re trying to paint a picture of the ‘dream’ of the future if the change is made, and the ‘nightmare’ of the future if it isn’t.)

3. What choice are you asking people to make and why now?

4. What action are you asking them to take and what impact will this have on the bigger picture? What’s the risk, or, what would the future look like if we fail to act?
Brainstorming (from Pg. 44 of Organizer’s Handbook):

Use the table below to reflect on one last choice point but this time, one that your community faces now.

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Choice</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>- What is the problem your community faces? Why is it urgent to organize now? What stories or images can you convey to make the challenge real for your listeners?</td>
<td>- What will the future look like if we fail to act? What could the future look like if we do act?</td>
<td>- What choice are you asking people to make? It it clear what form their action will take and how it fits within the bigger picture (the ‘dream’ of the future you’ve described)?</td>
</tr>
</tbody>
</table>

Draft an outline of your Story of Now below:

Tell the story of how this moment is an opportunity to protect or promote your/our value.

- **Self:** *I fight for climate action because I value ____.*
- **Us:** *But we all value ____.*
- **Now:** *And right now, we face a challenge that threatens our value of ____ (or we have an opportunity to promote our value of ____). If we make the choice I’m suggesting, we can enjoy the outcome together, for we will have promoted our shared value of ____.*

*Note: as you write your Story of Now, do not write a script. Rather, write an outline, which allows for organic delivery.*
Main value (should be the same value from your Story of Self and Us): _____________________.

<table>
<thead>
<tr>
<th>Challenge:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Choice:</td>
<td></td>
</tr>
<tr>
<td>Outcome:</td>
<td></td>
</tr>
</tbody>
</table>

**Important for Next Time:**
- Optional prep: Refine Story of Now and practice linked stories.
Module B-4: Public Narrative IV - Linked Stories
From material by Marshall Ganz

Activity: Coaching Story of Now

Goal: Practice coaching and refine Story of Now.

Coacher:
- Coach your partner’s Story of Now using the Coaching excerpt summarized in two modules above on Workbook Pg. 24.

Coachee:
- Take notes and revise your Story of Now.

Then switch roles!

Coachee: Use this space to note feedback on your Story of Now from your partner. Edit the story accordingly.

Public Narrative

Summary from Pg. 11 of Organizer’s Handbook

A public narrative consists of three distinct stories that are threaded together by a common value.

- A Story of Self communicates the values that have called you to leadership.
- A Story of Us communicates the values shared by those in action.
- A Story of Now communicates an urgent challenge to those values that demand action now.

Activity: Link Stories

Goal: Link stories of Self, Us, and Now to create public narrative.

Draft and rehearse:
- Work on combining all three stories, all linked by the main value you identified.
- Your public narrative should be roughly 2 minutes.

Main value in Public Narrative: ________________________.

Linking stories (from Pg. 45 of Organizer’s Handbook):
- Which choices in your life have led you to be here today? Pick one or two that relate to this community and this moment.

- What is this community all about and which stories reveal that? What specifically moves you about this community?

- What challenges make you feel enough (or angry enough) to act? What gives you hope? What specific choice are you asking people to make?

Draft and reflect on how all three stories come together below:

**Important for Next Time:**
- Public narrative coaching sessions.
Module B-5: Public Narrative V - Linked Stories

From material by Marshall Ganz

Activity: Coach Public Narrative 1

**Goal:** Practice coaching and refine Public Narrative.

**Coach:**
- Coach your partner’s Public Narrative using the [Coaching](#) excerpt summarized on Workbook Pg. 24.

**Coachee:**
- Take notes and revise your Public Narrative.

Then switch roles!

Coachee: Use this space to note feedback on your Public Narrative from your partner. Edit the story accordingly.
Activity: Coach Public Narrative 2

**Goal:** Practice coaching and refine Public Narrative.

**Coach:**
- Coach your partner’s Public Narrative using the [Coaching](#) excerpt summarized on Workbook Pg. 24.

**Coachee:**
- Take notes and revise your Public Narrative.

Then switch roles!

Coachee: Use this space to note feedback on your Public Narrative from your partner. Edit the story accordingly.

**Important for Next Time:**
- Start the Module C: Negotiation.
- **Study your iDecisionGames instructions for 67 Fish Pond Lane, and prepare to negotiate however you see fit** (60-90 minutes). It may feel intense or disorienting; if you’re not prepared, it ruins the simulation for both you and your partner. Do not discuss your instructions, as they are confidential.
Module C-1: Negotiation I - Value Claiming

- **BATNA**: Best Alternative To a Negotiated Agreement. It is defined as the most advantageous alternative that a negotiating party can take if negotiations fail and an agreement cannot be reached.

- **ZOPA**: Zone Of Possible Agreement. The zone of possible agreement is considered an area where two or more negotiating parties may find common ground. It is this area where parties will often compromise and strike a deal.

Room for note taking:

**Activity: 67 Fish Pond Lane Simulation**

**Objective:** Run 67 Fish Pond Lane simulation on iDG.

**Before starting:** Take a moment to write down your BATNA, reservation price, and aspiration price in the space below.

**Simulation rules:**
You will have 25 minutes together: 20 to negotiate, plus an additional 5 to give each other feedback.
● Treat the simulation as real.
  ○ Introduce yourselves appropriately.
  ○ Exit appropriately.
  ○ Don’t ask, “How’d you do?” afterwards.
● Reach an agreement only if it serves your long-term interests.

Feedback:
When you’re done, ask for feedback. Questions to ask include:
  ● How did you feel about the process? Was it fair?
  ● How did you feel about our relationship? Is there trust?
  ● How did you feel about yourself? Did I help you feel confident?
  ● How did you feel about the outcome? Did you feel you “did well?”
  ● How can I improve?

Reflection:
Reflect in the table below on how the simulation went.

Before starting:
  ● BATNA: _________________
  ● Reservation Price: _________________
  ● Aspiration Price: _________________

Room for feedback and reflection:
### Important for Next Time:
- Read your *iDecisionGames* instructions for New Recruit (~20 min). If you’re not prepared, it ruins the simulation for both you and your partner. Do not discuss your instructions, as they are confidential.

### Key Takeaway:
- Notice when you’re trying to claim value. Think about your BATNA and the other person’s BATNA.

<table>
<thead>
<tr>
<th>Went Well</th>
<th>Do Differently</th>
</tr>
</thead>
<tbody>
<tr>
<td>67 Fish Pond Lane</td>
<td></td>
</tr>
</tbody>
</table>
Module C-2: Negotiation II - Value Creation

Value creation: finding solutions that benefit both parties.

Focus on interests, not positions. Establish why everyone wants what they want.

Invent options for mutual gain.

Create objective value (money, time, etc.) and subjective value (self-confidence, trust, etc.).

There exists a tension between claiming value and creating value.

The negotiator’s dilemma: use tit-for-tat.

<table>
<thead>
<tr>
<th>Value Claiming</th>
<th>Value Creation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relationship not valued</td>
<td>Relationship valued</td>
</tr>
<tr>
<td>Fixed pie assumed</td>
<td>Expandable pie assumed</td>
</tr>
<tr>
<td>Competitive mindset</td>
<td>Cooperative mindset</td>
</tr>
<tr>
<td>Withhold information</td>
<td>Share information</td>
</tr>
<tr>
<td>Mislead or exaggerate</td>
<td>Be truthful and open</td>
</tr>
</tbody>
</table>

Be nice.
Be clear.
Be provokable.
Be forgiving.
Activity: New Recruit Simulation

**Objective:** Run the New Recruit simulation on iDG.

**Before starting:**
Note:
- If you are a *candidate*, you are negotiating on behalf of a close friend.
- Do not make things up about your company or about your friend. The goal is to explore each other’s interests and create different options. As in real-life negotiations, fabricating stories will not help.

**Simulation rules:**
You will have 30 minutes together: 25 to negotiate, plus an additional 5 to give each other feedback.
- Treat the simulation as real.
  - Introduce yourselves appropriately.
  - Exit appropriately.
  - Don’t talk about points, e.g. “How many points is that worth?”
- Reach an agreement only if it serves your long-term interests.

**Feedback:**
When you’re done, ask for feedback. Questions to ask include:
- How did you feel about the process? Was it fair?
- How did you feel about our relationship? Is there trust?
- How did you feel about yourself? Did I help you feel confident?
- How did you feel about the outcome? Did you feel you “did well?”
- How can I improve?

**Reflection:**
Reflect in the table below on how the simulation went.

Room for feedback and reflection:
<table>
<thead>
<tr>
<th></th>
<th>Went Well</th>
<th>Do Differently</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Recruit</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Important for Next Time:**
- *Read your instructions for Three-party Coalition* (~30 mins). If you’re not prepared, it ruins the simulation for both you and your partner. Do not discuss your instructions, as they are confidential. **This case will be emailed to you.**

**Key Takeaways:**

**Suggested exercise:**
- *Notice when you’re negotiating. Be intentional about sharing and learning interests.*
- *Use silence.*
Module C-3: Negotiation III - Building Power and Overcoming Barriers

Use the Seven Elements to prepare for your negotiations.

1. **Parties and interests:**
   a. Map the stakeholders.

2. **Alternatives:**
   a. Think about each side’s alternative. What’s our BATNA? Their BATNA? How can each side influence the other’s BATNA?

3. **Options:**
   a. Write down different ideas to satisfy everyone’s interests. When you share the ideas, make sure it’s clear that you’re simply inventing options – not deciding.

4. **Legitimacy:**
a. Why is your position legitimate? Why might your counterpart say theirs is legitimate? We talked about this during value claiming: List objective criteria to use as a sword and shield.

5. Relationship:
   a. Does it have a history? Will it have a future?

6. Communication:
   a. What medium should we use? How can we make the other side feel heard?

7. Commitment:
   a. Finally, think about the type of commitment you expect to make. What would be a realistic outcome of the meeting? How can you prepare?

Activity: Three-Party Coalition Simulation

Objective: Run the Three-Party Coalition simulation.

Simulation rules:
You will have 15-20 min.
- Treat the simulation as real.
  - Introduce yourselves appropriately and exit appropriately.

Room for feedback and reflection:
Important for Next Time:

- Next session we will have the Harborco simulation aka. the Negotiation Module “Capstone”
- **There are two documents to read, both on iDG.** One of them is an overview document; the other one is specific to your role. Make sure you read both (~1-1.5 hrs).
- **Please tell your teaching team ASAP if there’s a chance you won’t make it.**
- Please look on iDG to find out who you’ll be negotiating with. If two people have been assigned to your role, you will represent that role together as partners.

Other logistics for Harborco:

- HarborCo involves three votes. Do not submit the results until you’ve done all three votes.
- **You’ll be running the negotiation yourselves.** Each group will have a coordinator. This person, in addition to playing their assigned role, will create a Zoom room and keep track of time to make sure votes happen at the right increments.

Key Takeaways:

- *Think about the seven elements before your negotiations.*
- *Be creative in searching for power.*
Module C-4-5: Negotiation IV-V

Activity: Harborco Reflection

<table>
<thead>
<tr>
<th>Reflection: Reflect in the table below on how the simulation went. Possible questions for reflection:</th>
</tr>
</thead>
<tbody>
<tr>
<td>● How did you manage your emotions?</td>
</tr>
<tr>
<td>● Did you use anything from difficult conversations?</td>
</tr>
<tr>
<td>● Would it have been different in person?</td>
</tr>
</tbody>
</table>

Room for feedback and reflection:

<table>
<thead>
<tr>
<th>Went Well</th>
<th>Do Differently</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harborco</td>
<td></td>
</tr>
</tbody>
</table>
Important for Next Time:
- Start of Module D: Communication. Please come prepared with a climate-related topic you’d like to give a speech about.

Key Takeaways:
- *Take into account your short- and long-term objectives. Do you want to risk damaging your relationship?*
- Suggested exercise: Negotiate something you wouldn’t normally negotiate for.
Module D-1: Communication I - Introduction

From Resonate and Trees, Maps, and Theorems

Three Rules of Communication
Rule 1: Adapt to your audience
Rule 2: Maximize signal-to-noise ratio
Rule 3: Use effective redundancy

Three Persuasive Appeals
a. Ethos: Character
b. Logos: Logic
c. Pathos: Emotion
d. (Bonus!) Kairos: Timing

Activity: Climate Persuasion Speech

Goal: Practice persuasion.

Take some time to create a 1-minute speech on climate change. We’ll be working with this topic for the next four workshops, so pick something that interests you. E.g. Maybe it’s convincing us that eating less meat is a great way to make a difference.

Choose a specific audience and purpose: what would the audience have to do for you to say your speech was successful?

Use the three rules of communication and the three persuasive appeals. Consider using contrast.

Remember: We speak to make an impact!
Questions for reflection:

- How did you feel about giving the presentation?
- What went well? What would you do differently?

Room for reflection:

Key Takeaway:

- Use the three rules of communication and the three persuasive appeals. Consider using contrast.
- Suggested exercise: Notice examples of contrast in communication, whether it’s visual, verbal, musical, physical, or otherwise.
Module D-2: Communication II - Planning
From Resonate and Trees, Maps, and Theorems

This session is an interactive workshop where you will learn how to plan a presentation. We’re going to work on the speech you first gave last week throughout this workshop. Fill out questions below interactively as the speaker goes through their slides.

Planning

Questions to answer when working on a presentation or paper.

<table>
<thead>
<tr>
<th>Question 1: Why are we doing this?</th>
</tr>
</thead>
<tbody>
<tr>
<td>What should the audience do (or be able to do) when they’re done?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question 2: Who are we doing it for?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Who is your audience in terms of demographic, disposition, and knowledge?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question 3: What are we going to say to them?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generate content based on your Why and Who.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question 4: How are we going to structure it?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structure content to maximize understanding and retention.</td>
</tr>
</tbody>
</table>

Fill out interactively throughout workshop:

Why: *What should the audience do (or be able to do) when they’re done?*

Who: *Who is your audience in terms of demographic, disposition, and knowledge?*

- Lifestyle: what’s likable and special about them? Where do they hang out?

- Values: what’s important to them? How do they spend time and money?

- Influence: who/what influences their behavior? How do they decide?
- Motivation: what do they need? What gets them out of bed?

- Respect: How can you make them feel respected?

- Knowledge: what do they already know? Where do they get knowledge?

**What:** Generate content based on your Why and Who.

The Big Idea: a complete sentence that articulates your point of view and conveys what’s at stake.

How will the audience resist? Use these concerns as inoculants.

- Comfort zone: What’s their tolerance for change? How far are you pushing?

- Misunderstanding: What might they misunderstand about your message?

- Fear: What keeps them up at night? Identify fears, valid and otherwise.

- Obstacles: What will stop them from adopting/acting on your message?

- Vulnerabilities: In which areas are they vulnerable? Any recent changes?

- Politics: Who or what has influence over them? Will your idea affect this?

What’s in it for them?

- Benefit to them: How will they personally benefit from adopting your idea?
• Benefit to sphere: How will this help their sphere of influence?

• Benefit to humankind: How will this help the humans or the planet?

Generate content – and be creative, as we’ll filter later.

<table>
<thead>
<tr>
<th></th>
<th>What is</th>
<th>What could be</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Head:</strong></td>
<td>Logic, Facts, Reason</td>
<td></td>
</tr>
<tr>
<td><strong>Heart:</strong></td>
<td>Hope, Sadness, Fear</td>
<td></td>
</tr>
<tr>
<td><strong>Gut:</strong></td>
<td>Anger, Humor</td>
<td></td>
</tr>
<tr>
<td><strong>Groin:</strong></td>
<td>Power, Lust, Status</td>
<td></td>
</tr>
</tbody>
</table>

Filter your content, then turn it into messages.

• Every sentence should relate to your big idea, so filter everything that doesn’t.
• Then turn each idea (or cluster of ideas) into a message: not just information, but meaning.

**How:** *Structure content to maximize understanding and retention.*

Theorem (aka big idea):

• Point 1:
  o Subpoint 1a
  o Subpoint 1b
  o Subpoint 1c
• Point 2:
Intro:
- Grab their attention.
- Describe the need.
- Address this need.
- Share your thesis and map.

Ending:
- Review.
- Conclude.
- Close.

Key Takeaways:
- Four questions needed to plan a presentation: Why? Who? What? How?
- The Big Idea: a complete sentence that articulates your point of view and conveys what’s at stake.
- Suggested exercise: Notice the framings around you. Whom do they benefit?
Module D-3: Communication III - Designing

Workshop Part 1: Designing

**Design of presentations**

1. Assertion-Evidence
2. Presenting Data: Less is more
3. Special Slides and Mapping

**Mapping Slides**

Mapping slides are functional for two reasons:

1. Audiences need a map
2. Mapping slides provide opportunity for contrast

**Activity: Designing**

Objective: Create one assertion-evidence slide, one mapping slide, and one emphasis slide for climate speech you’ve been working on. Also create a blank slide, just for your reference.
Activity: Writing Pt. 1

Objective: Fix these sentences. Write them in your voice.

- “There are various groups that think you can ban certain kinds of guns. I am not in that mode. I am in the mode of being deeply concerned.” – Bush

- Among the additional functional enhancements are dynamic reconfiguration and communications.

- The acceleration of our competitors in the integration and weaponization of artificial intelligence is an effective measure for countering our advantages.

Activity: Writing Pt. 2

Objective: Fix these sentences. Strip every sentence to its cleanest components.

- I believe climate change is quite clearly a function of human emissions, in the sense that it results from overly careless actions on the part of many.

- Perhaps one of the most obvious feelings one gets when looking at the ocean is just awe at its beauty.
All things considered, I bet that a little love and tenderness would pretty much cure him of his nihilism.

Objective: Fix these sentences. Create unity with consistent pronouns, tense, and mood.

- First, I poured water into the beaker. Then, hydrochloric acid was added.
- I had slept, and now I feel awake.
- Outside, the rain intensified. John reclined in his chair; he enjoyed drinking, and the weather excused his habit. What a terrible person.

Activity: Writing Pt. 3

Objective: Fix these sentences. Evoke an image: Use active verbs, avoid “to be”, and remove clichés.

- The man was stunned by the accident.
- Their philosophy is that leadership is important to success.
- Those white women’s faces behind the black girl at Little Rock stick with you.

Important for Next Time:
- Next time we will learn how to deliver presentations – It will be weird and fun ☺
Module D-4: Communication IV - Delivering

Activity: Delivery

Goal of this activity: Deliver a speech and then watch a recording of yourself and write feedback in the table below.

<table>
<thead>
<tr>
<th>Went Well</th>
<th>Do Differently</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Important for Next Time:
- Last session of EarthDNA Ambassador Training!

Key Takeaways:
- Practice visual and vocal delivery.
- Warmup your breathing, energy, and articulation.
Recommended Readings

**Communication**
- Resonate
- Storytelling with Data
- Trees, Maps, and Theorems
- On Writing Well
- Don't Think of an Elephant

**Negotiation**
- Getting to Yes
- Difficult Conversations
- The Power of a Positive No
- Pre-Suasion
- Negotiation Genius
- 3D Negotiation
- Negotiating the Impossible

**Other**
- Grit
- The Charisma Myth
- Leadership on the Line
- Leadership without Easy Answers
- Thanks for the Feedback
- Finding Your True North
- The Body Keeps the Score
- How to Be an Anti-Racist
- Master of the Senate

**Public Narrative**
- [Public Narrative, Collective Action, and Power](#)
- [Public Narrative](#) by Resistance School
- Anything written by Marshall Ganz