H-Environment

H-Environment Roundtable Reviews

Volume 5, No. 10 (2015)
https://networks.h-net.org/h-environment

Publication date: December 21, 2015
Roundtable Review Editor: Christopher F. Jones

Ashley Carse, *Beyond the Big Ditch: Politics, Ecology, and Infrastructure at the Panama Canal* (Cambridge, Mass.: The MIT Press, 2014). ISBN: 9780262028110

Contents

Introduction by Christopher F. Jones, Arizona State University

There is a special delight in scholarship that takes a familiar subject and casts it in a new light. ***Beyond the Big Ditch*** is one such work. **Ashley Carse** begins with one of the most famous projects of modern times—the Panama Canal—but instead of rehashing stories of heroic engineering or American imperialism, he turns to the canal's natural environment. In particular, he is interested in the social and political consequences of the landscape transformations considered necessary to maintain this infrastructural system. Noting that each ship crossing the canal requires more than fifty million gallons of freshwater to ascend and descend the locks, Carse grounds his study in the region's hydrology. As a result, he highlights topics such as the rise of watershed management, the agricultural practices of rural Panamanians, and the challenges of hyacinth weeds. Suiting the variety of his topics, Carse is similarly diverse in his intellectual approach: he utilizes methodologies ranging from ethnography to archival research and draws on intellectual approaches including geography, environmental history, political ecology, and science and technology studies.

One benefit of Carse's approach is that he helps further break down the boundaries between technology and the environment. In one of the most celebrated and cited analyses of infrastructure, *Networks of Power*, Thomas Hughes explicitly described the environment as being constituted by those elements *outside* the technological system. Current work by envirotech scholars has done a great deal to demonstrate that such divisions are "illusory" and Carse provides one of the clearest and most compelling examples to date.[1] The environment did not disappear from the story once the concrete had been poured and construction workers no longer had to fight off mosquitos, he argues. Instead, a great deal of effort went into securing necessary supplies of water, policing rural farmers, and managing weeds to be sure the canal could continue to operate. Nature and infrastructure, he shows, are thoroughly entwined.

The book is also a welcome reminder that infrastructures benefit some more than others. Maintaining the integrity of the waterway clearly served the interests of global shippers, producers, and consumers while revenues from the canal boosted government coffers. These gains came, largely, at the expense of rural Panamanians. New developments in watershed management in the 1970s and 1980s blamed the swidden agricultural practices of campesinos for causing deforestation that destabilized the region's ability to supply water to the canal. Remarkably, the humble machete suddenly appeared as a viable threat to one of the world's largest infrastructures. Shifting epistemologies, therefore, justified a host of coercive measures aimed at restricting the actions of campesinos to ensure that their attempts to sustain themselves did not disrupt global commerce.

---

[1] Thomas Hughes, *Networks of Power: Electrification in Western Society, 1880-1930* (Baltimore: Johns Hopkins University Press, 1983); Martin Reuss and Stephen Cutcliffe, eds. *The Illusory Boundary: Environment and Technology in History* (Charlottesville: University of Virginia Press, 2010).

Ann Greene offers the first commentary in this roundtable, helping place the Panama Canal in context with other major systems such as the Suez and Erie canals. One of the earliest and most regular participants in the envirotech interest group, Greene is currently pursuing research on an environmental history of the Erie Canal. Her book *Horses at Work* offers a fascinating analysis of the long history of horse power in America and the complex relationships between animals, work, technology, and industrialization.[2]

Bringing a perspective from Latin America, **Marixa Lasso**'s comments situate Carse's work within Panamanian histories of the canal. Lasso's *Myths of Harmony* offers a nuanced analysis of the complexities of racial construction and political sovereignty in Colombia's Age of Revolution. Her present research is examining population patterns in the Canal Zone.[3]

An accomplished scholar with wide interests, I invited **Chandra Mukerji** to join this roundtable because her research offers powerful insights into the intersections between infrastructures and state power. Many of her works, including *A Fragile Power*, *Territorial Ambitions and the Gardens of Versailles*, and *Impossible Engineering* have become canonical works in science and technology studies and related fields.[4]

Last but certainly not least, **Daniel Macfarlane** raises important questions about the presentation of research findings in interdisciplinary contexts. His recent book *Negotiating a River* provides a compelling examination of the St. Lawrence Seaway, another of the twentieth century's hydrological megaprojects involving international diplomacy, power politics, landscape disruption, global commerce, and the forced removal of populations. He is currently engaged in several projects examining transnational waterways including Niagara Falls and the Great Lakes.[5]

Before turning to the first set of comments, I would like to pause here and thank all the roundtable participants for taking part. In addition, I would like to remind readers that as an open-access forum, *H-Environment Roundtable Reviews* is available to scholars and non-scholars alike, around the world, free of charge. Please circulate.

---

[2] Ann Greene, *Horses at Work: Harnessing Power in Industrial America* (Cambridge, MA: Harvard University Press, 2008).
[3] Marixa Lasso, *Myths of Harmony: Race and Republicanism during the Age of Revolution, Colombia, 1795-1831* (Pittsburgh: Pittsburgh University Press, 2007).
[4] Chandra Mukerji, *A Fragile Power: Scientists and the State* (Princeton: Princeton University Press, 1990), *Territorial Ambitions and the Gardens of Versailles* (Cambridge: Cambridge University Press, 1997), and *Impossible Engineering: Technology and Territoriality on the Canal du Midi* (Princeton: Princeton University Press, 2009).
[5] Daniel Macfarlane, *Negotiating a River: Canada, the US, and the Creation of the St. Lawrence Seaway* (Vancouver: University of British Columbia Press, 2014).

Comments by Ann N. Greene, University of Pennsylvania

In *Beyond the Big Ditch: Politics, Ecology and Infrastructure at the Panama Canal*, Ashley Carse examines the history and operation of the Panama Canal through the lens of its environmental history, arguing for an understanding of infrastructure that goes beyond material artifact. Carse describes infrastructures as processes "of relationship building and maintenance," (p.11) developing out of specific environments to extend over time, space and society, bridging different scales of operation and influence. Thus the Panama Canal anchors an infrastructure that is globalized yet shaped by local conditions, and with very local as well as global outcomes. Carse borrows Geoffrey Bowker's method of "infrastructural inversion" to focus on the network of social and ecological relationships that have developed and changed over a century of Canal construction and operation. He challenges the iconography of the Panama Canal as "big ditch" to show that as a lock-based rather than a sea-level canal, its human-built infrastructure is dependent upon and therefore embedded in the hydrological infrastructure of the Isthmus. The Canal shaped a new water landscape of lakes, dams, channels and locks, but is also shaped by the natural forces of the environment. But as Carse points out, the Canal, whether under American or Panamanian control, is not the only infrastructural project in Panama. It has come into conflict with the rural development infrastructures of the Panamanian state. Each of these infrastructures has given rise "to political ecologies with winners and losers" (p. 6), which Carse explores through ethnographic research into the changing fortunes of rural populations, especially the small farmers of the region. Carse goes beyond a traditional environment declension narrative of impact to seeing process and interaction, with agency on different scales among the various stakeholders.

The big canals of the last two centuries have been the Erie Canal, the Suez Canal, and the Panama Canal, and each has generated a substantial literature. However, Carse's book is unique in bringing together aspects of canal construction and operation that often fall into separate literatures, such as political economy, engineering, technological change, shipping and trade, globalization, social history, water management, or environmental history. In contrast, Carse has written an account that knits together these literatures.

He does this by keeping water at the center of this project. It is so obvious that canals are infrastructures that contain and transmit water that canal water is taken for granted and naturalized into invisibility. By using the method of "infrastructural inversion" Carse restores the centrality of water to a consideration of the Panama Canal. For the people in charge of the canal, all the questions are about water. What canal administrators think about all the time is having enough water in the canal to support traffic, where to get enough water to make that happen, how to store enough water to protect water levels, and how to keep the right water (a managed flow) in and the wrong water (flood water and other damaging elements) out. Questions about water tie canals to their environments, and are powerful reminders

that these human built structures are embedded in and therefore dependent upon the natural water structures of their sites.

The problem of water illustrates just how the Panama Canal is not a "big ditch." The Suez Canal was a "big ditch" because it was a sea level canal allowing the water from the Mediterranean and the Red Seas to flow into it. However, the Panama Canal, like the Erie Canal, is lock-based. It requires water sources from interior regions. Locks by definition transmit water down the canal elevations from the summit levels (highest points) to the bodies of water at the terminuses. The Panama Canal flushes water from the summit level of the Chagres River, through Gatun Lake (created by damming the river to create the lake as both route and reservoir) into the Atlantic and Pacific Oceans. Carse opens the book with the gripping statistic of what this means: every ship that passes through the Canal flushes a total of 52 million gallons of fresh water into the oceans (p. 3) as it goes up and down the staircases of locks at each end. This statistic frames Carse's account of the interaction between the environmental and the technological aspects of the Panama Canal, and the surrounding network of social, political and economic relationships that develop around questions of water supply and management.

Carse focuses on the watershed of the Chagres River. One of the most interesting sections of this interesting book is the historicizing and politicizing of the watershed concept. Watersheds are one way that humans frame natural systems. The watershed concept developed during the nineteenth century, when "watersheds" were first scientifically described and mapped. The naturalization of watershed boundaries often masks the politics of these boundaries and how watersheds become administrative units. An important part of the watershed concept concerns the relationship between forests and water—that forests need to be protected in order to protect water levels and prevent erosion. Forest and water policy in the Isthmus rests on an assumed connection between forests and water flow that is still not well understood by forest scientists and hydrologists. Yet the assertion of this connection has had dramatic consequences. Based on this assumption, the Panamanian government has created forest preserves in order to protect the headwaters of the Chagres River and water levels in the Panama Canal. This has caused the government to relocate small farmers who under previous rural development policies had been encouraged to settle these areas and clear the forest.

The use of the watershed concept as an organizational device feels like the systems approach of Thomas Hughes, who on the first page of *Networks of Power* (1983) states that "technological affairs contain a rich texture of technical matters, scientific laws, economic principles, political forces and social concerns" (p. 1), a sentence that almost outlines Carse's book. Though Hughes dealt little with natural environments he nonetheless noted, "Those parts of the world that are not part of the system's control, but that influence the system, are called the environment" (p. 6), and further noted that the boundaries of systems were constructed rather than inherent. By making the system under analysis a watershed, an environmental construct, Carse continues to develop the envirotech approach to studying both environments and

technology that developed among members of SHOT and ASEH in the late 1990s, and which is laid out in the 2010 volume, *The Illusory Boundary: Environment and Technology in History.* To this methodology he adds an anthropologist's ethnographic methodology and organizational style. Rather than a strictly chronological narrative, Carse follows the flow of water through the geographical spaces of headwaters, floodplains, interiors and backwaters, a sequence of sources, results, and unintended consequences. He moves back and forth between past and present within this framework. His focus on the transmission of water is in keeping with the developing focus on connections between sources and consumers, as is found in Christopher Jones' recent *Routes of Power* (2014). By passing through the locks, the ships consume the water that originates in the headwaters of the Chagres River, but the real story is about the transmission of water, how and why the water gets from headwaters to locks.

One backstory to this book is the global impact of American progressivism in the late nineteenth and early twentieth centuries, as engineering developed as a powerful way of defining and solving problems. The Panama Canal brought together key progressive concerns: social order, rationalized systems, racial hierarchies, public health, executive power, technological solutions, and environmental management. One aspect of progressivism was environmentalism. The watershed concept and the assertion of a forest-watershed connection links what happened in Panama around the Chagres headwaters to American environmental history. In the 19th century, George Perkins Marsh argued in *Man and Nature* (1864) that deforestation impacted watersheds. Late century concern about water levels in the Hudson River and the Erie Canal drove protection efforts for upstate forests, and led to the creation of the Adirondack Park, which changed the material conditions and political power of 13,000 local residents--a story repeated with the expansion of the national park system under progressive environmentalism. These situations raise questions about the social consequences and power imbalances of protecting broad natural systems and processes.

Within Panama, the government seeks more interconnectedness through highways linking rural areas to urban areas and the canal. The rural populations that Carse studies want better integration as well. They are not seeking some romantic ideal of autonomous subsistence purity; on the contrary, they want electricity, bus service, and access to markets, education, and social institutions, which would result from the easier mobility provided by better roads. Their integration into larger Panamanian society is currently unpredictable and unmanageable because of poor energy and transportation infrastructures. Rather than making them independent and integrated, they are dependent and separated. The Panamanian government's rural development infrastructure reflects a desire for economic development not as an abstract goal, but for the returns in political and social development it might bring. This too is reminiscent of the American experience with transportation infrastructure. James Madison and Thomas Jefferson among others argued for internal improvements to knit together the young United States. Despite their celebration of the yeoman farmer, they were uncomfortable with populations that

were too autonomous and isolated. They advocated roads and canals in order to promote commerce, believing this to be the most natural and least dictatorial way to integrate people into one nation.

This book raises questions about the relationship between mobility and environmental change and provides questions for research in other situations where a large infrastructure project has created social and environmental change. Humans, who are highly adaptable to a wide variety of environments, are the weediest and most mobile of species, and accompanied by their sidekicks, the almost-as-weedy domesticated plants and animals, have wrought extensive environmental change simply by relocating. The changes resulting from the mobility project of the Canal in Panama and around the world, not to mention the colonialist circumstances under which the Canal was first constructed, would make it easy to condemn the entire enterprise. This kind of declension narrative doesn't get us very far, and this is not a battle Carse chooses to fight either. He takes the Panama Canal as a given. What is as interesting as the broad question of mobility as related to the Canal is the imperative to mobility within Panama. Transportation infrastructures such as the Panama Canal are both consequence and cause of the mobility that has knit the world into ever-tighter interconnectedness.

Carse's powerful and original argument brings together many topics that are difficult to address in one study, and does so with clarity and grace. Some questions for future research would include applying this model to other infrastructures. What else is like a canal? Could environmental narratives be organized around mobility? Could energy infrastructures such as electric grids, railroad networks, or urban water and sanitation infrastructures be analyzed in the same way? What are the terms on which we decide the merits of large infrastructures? Who are the winners and losers? Following Edmund Russell's arguments in *Evolutionary History: Uniting History and Biology to Understand Life on Earth*, are infrastructures like the Panama Canal evolutionary forces in some way? Carse focuses on some of the changes in crops and plant life in Panama, but what changes have occurred in animal populations? This is a book rich in further research questions. Carse's book demonstrates the complications of the politics, environmental and otherwise, of infrastructure and mobility.

Comments by Marixa Lasso, Universidad Nacional de Colombia

A couple of years ago, I found myself watching a PBS documentary about the building of the Panama Canal. Unsurprisingly, the documentary's tone was one of triumph and achievement. It enumerated the well-known engineering and medical battles against tropical nature. U.S. doctors conquered yellow fever and U.S. engineers mastered Panama's jungle and mud to build the canal. I was glad to see that the labor of the thousands of–mostly black West Indian—workers who built the canal was recognized. However, when the documentary finished, I was left with a deep sense of unease. There was little, if any, reference to Panama, the country where the canal was built, or to the Panamanians who lived—and live—next to it. In the documentary's narrative, the canal could have been built in any tropical South American location. But the canal was not built anywhere, it was built in Panama: a place with its own characteristics, people and history. The documentary stayed safely within the historic borders of the Canal Zone and among the life and work of Canal Officials. Thus, it was with great pleasure and interest that I read Ashley Carse's journey to the small towns and rural areas outside of the old Zone's border. Unlike other Panama Canal books, the bulk of his book focuses on the region right outside the Canal Zone and on the relationship between the Panama Canal and the rural Panamanians who have historically lived next to it.

I will leave it to other reviewers who are experts on environmental history and on the history of technology (I am not an expert on either field) to tell how this book enriches our understanding of these fields. Instead, I will focus on how this book changes our understanding of Panama's history. Carse belongs to a group of historians who are questioning the triumphalist historical narrative of the Panama Canal. This narrative was first challenged by Panamanian scholars who denounced the Canal Zone as a colonial enclave where Panamanians were treated as second-class citizens in their own country. The canal's triumphalist narrative was later denounced by labor historians who examined the life of the thousand of workers who built the Panama Canal and who endured the racial segregation that characterized most of the canal's history. However, both narratives did not undermine ideas that link infrastructure with progress and development. The question was who controlled and benefitted from the canal. It is not until recently that a new generation of environmental historians have addressed the ways in which changes in infrastructure and in public health brought by canal construction disrupted previous relationships between societies and their environment.

Carse's *Beyond the Big Ditch* looks at how the construction of the Panama Canal and the creation of Lake Gatún disrupted relationships between the people of the isthmian route and the Chagres River—the river that provides the water for the Panama Canal—that were centuries old. He shifts the emphasis of the Canal Zone seal's "the Land Divided the World United" from the world united to the land divided. By doing this he not only crosses the Canal Zone boundaries, but also some interesting and historiographical boundaries between histories of Panama and

histories of the canal. Panamanian histories focus on the isthmian route up to the creation of the canal. They narrate the story of colonial trade through the Chagres River and the mule paths that connected both oceans. They also tell the history of the nineteenth-century railroad construction. But after the construction of the Panama Canal, the Isthmian Zone fades away from Panama's history, as if its status as an American territory made it not relevant for local history except as a place to reclaim. Basic questions like: "what happened to the people of the Chagres River after the flooding of lake Gatún?" have not been posed. Carse's wonderful history answers this question. Through a combination of anthropological field research on the margins of Lake Gatún and on the Chagres watershed and archival research in US and Panamanian archives, Carse tells us the history of two communities: Boquerón—on an affluent of the Chagres River—and Nuevo Limón—close to Lake Gatún. Through them we learn the ebbs and flows of life along the Canal's watershed. Because of his focus on water infrastructure, political boundaries matter little. As he notes, not only the Chagres River flows through them, but also people and environmental management practices.

With the depopulation of the Canal Zone and the creation of lake Gatún many rural communities—like Limón—were forced to abandon their flooded lands and to relocate outside the Canal Zone. Yet, this did not mean that they lost connections with the Canal and its Zone. Lake Gatun replaced the Chagres River as a waterway for internal communication and peasants continued to cultivate on its shores following agriculture patterns that preceded canal construction. For example, they cultivated bananas for exportation and family plots for their own consumption. These rural communities were also affected by various development projects of the 20th century that sought to develop the area around the canal by encouraging agricultural colonization and mining. The life of these watershed communities were again dramatically disrupted in the 1970s. This decade witnessed the emergence of new environmental ideas, which considered that to maintain adequate canal water levels it was necessary to protect the forest of the canal watershed by forbidding peasant agriculture in this area. Both the Panamanian and U.S. governments agreed on this new environmental policy about the appropriate use of the canal area. The reconceptualization of the Canal watershed might not have been as disruptive as the construction of the canal, but it altered local lives in new and fundamental ways. Peasants went from being the spearhead of agricultural development to becoming an environmental nuisance. Like in 1912, local peasants were once again seen as a threat to the canal's functioning.

Carse's book also forces the reader to rethink established twentieth-century Panamanian ideas that divide the country into natural historical regions of agriculture, such as the west part of the country, where cattle ranches, sugar cane plantations and polleras seem to naturally belong and jungle regions, such as the Isthmian Zone, where peasants are portrayed as intruders. He reminds us that agriculture has a long history on the Isthmian route and that the forest around the canal watershed is often of recent creation. Although not the explicit purpose of this

book, it invites us to think about the pitfalls of concentrating water management and preservation solely on the Canal watershed.

My one quibble is that perhaps he went to far in his focus on the rural life around the canal. I wondered what was the role of urban Panamanians in this story. Their absence was particularly surprising in the discussion of the Transístimica highway, which divided the world between Zonians driving cars and Panamanian peasants without cars. Yet by this time cars were present in Panama City and in Colon City, and not only among the elite. Also the isthmian highway became an important area of suburban sprawl. How do these urban changes relate to the environment of the canal watershed?

This beautifully written and engaging book changes in fundamental ways the histories of Panama and its canal. I hope it circulates widely and becomes an important reading for Panamanian historians, environmentalists, government officials, and members of the ACP (Panama Canal Authority).

Comments by Chandra Mukerji, UC San Diego

I started reading *Beyond the Big Ditch* with uncharacteristic pleasure. I am often slow to warm up to a book and reluctant to embrace its argument. But I was immediately taken by the charming writing style and the global vision of the author, Ashley Carse. I felt as though I had been transported to Panama with its canal, forests, rivers, and people. I loved that the author, an anthropologist of science and technology, situated his study in a village close to the Panama Canal rather than at the canal itself. Here was a story of territorial engineering and global power told from a village near the Panama Canal. What a viewpoint! What a pleasure!

Carse did not put the Panama Canal "in context" either, painting a simple picture of it as a great modern monument surrounded by an ancient environment of people and things. Instead, he told stories of peasants, forests, rivers and lakes that shifted and moved to accommodate the canal, and histories of villages that were drowned or moved to provide its water needs. The environment was a palpable, shifting force in this history-- both the natural and built environment. And peasants faced with "modern" infrastructures that came (and then often went) continued to forge ways of life in new circumstances. Carse argues that these waves of new infrastructures did not so much link people and places as create distance between them, and this seemed to include distance from their own histories.

Carse makes infrastructures seem like storms that uproot lives, and place demands on people to accommodate. The Panama Canal might seem to outsiders to connect Panama to the world, but it ripped the country apart, too. It did not just link seas, but bisected the country. And the needs of the canal – particularly for water — made it an invasive infrastructure that kept reaching further into the countryside to feed itself.

The Panama Canal in Carse's story is a sociopolitical tool of the U.S., too, that gives it sociopolitical power as an element of Panamanian life. It is not an object stabilizing the environment by heroic and modern engineering. On the contrary, this canal is thirsty and has powerful allies in seeking alimentation. So, it can be demanding. For locals, the Panama Canal is not bad because it can be a source of employment. But its needs conflict with local life and Panamanian policies.

The Panama Canal is a modernizing force for Panama, but not the only one. Carse shows his readers evidence in the environment of development and modernization drives that have shaped villages and formed lives. There are abandoned roads and railroads that served lumbering and mines. There are signs in the forests, too, of where peasants have cut down and burned trees in order to grow gardens. There are signs along the river of where trees were dragged and floated to market.

The chapters of the book reveal its environmental concerns, focusing on gardening practices, rivers, a lake, and even waterweeds. But what I miss in this book is the forest. It always remains hovering at the edge of the stories of infrastructure that the author tells. Trees are bulldozed to make roads. And trees are felled for lumber. The forests are penetrated by railroads for mines. And mines pollute the forest. The Panama Canal denudes the land of trees. These stories of demands on the forest are all in the book, but I don't see any trees. There are banana trees grown for the export market, but not the trees they displaced.

I probably should not have hoped for trees since this is a book about infrastructure and power, and particularly the use of engineering for creating patterns of territorial power. And it has an interesting story to tell about infrastructure that seems original and important. Governments fashion modern infrastructures to shift social relations and do so in successful waves that can overlap and contradict. Carse makes clear that modernization is not simple or singular, and that economic development is not linear. The threats to the forests understood as threats to the Panama Canal are products of modernization drives by the Panamanian government. Roads, mines, plantations, and deforestation for agriculture are all effects of modernization drives, trying to bring modern amenities and economic activity into rural Panama.

Carse reminds us that infrastructures are demanding by their nature because they are not stable and require work to maintain. The Panama Cana—because of its size—simply makes this more visible because of the scale of its demands. Infrastructures are as dynamic as the land and communities around them because they are part of them, and they are dynamic as political actors, too, using the clout of their allies to arrange social and material conditions to assure their success.

Comments by Daniel Macfarlane, Western Michigan University

The Panama Canal is an iconic water megaproject. It is shorthand for something of immense scale, scope, and importance, and seems to be the standard against which other modern canal systems are inevitably compared. Rivers of ink have been spilled on this seminal hydraulic engineering achievement, and the torrent of books has shown no signs of slowing down a century after its completion. There are a number of discernible historiographical approaches and stages, though there is not space to do them justice here. Much of the work concentrates on the role of the United States, particularly in terms of U.S. foreign relations, empire, and economics, but there is a substantial literature on the Panamanian political, nationalist, and social history. As of late, the literature has, unsurprisingly, taken a cultural turn. But the engineering and technological aspects of the canal also continue to attract a tremendous amount of attention, spawning a cottage industry often aimed at a more popular audience.

Given that so much has been written about the Panama Canal from varying perspectives, what separates Ashley Carse's *Beyond the Big Ditch*: *Politics, Ecology, and Infrastructure at the Panama Canal*? First off, Carse employs a novel approach. Moreover, in significant ways this is not a book about the Panama Canal so much as it is about what goes on around it. Carse is interested more in problematizing and complicating a story that we think we already know, rather than providing a new history of the waterway. Readers will find very little about treaties and tolls, or dams or diplomats. If the focus of the book were to be distilled down to one word, it would be "infrastructure." To expand a touch, this book looks at the nature of infrastructure, revealing how transportation networks are entangled with their surrounding environments.

Carse is an anthropologist who uses ethnographic and political ecology techniques to look at environmental management and the politics of the built environment, mostly in the past. Carse states that he is conducting "an infrastructural inversion" of the Panama Canal by turning "upside down" its infrastructures in order to analyze the ways that they inform social organizations and, in the process, uncover the often overlooked "background work" (20). The waterway infrastructure shapes the surrounding landscapes, but it is not a unidirectional process of domination, for transportation routes become dependent on the ecologies they cross. Nature becomes a necessary part of the infrastructure. Indeed, one of the key takeaways is that engineered transportation networks (canals and highways) need to be placed within their social and ecological dimensions, not viewed as abstract technical achievements divorced from their surroundings. But these relationships and interconnections also have a way of turning environmental issues into "friction" – that is, problems and conflicts over resources.

Panama Canal administrators, be they American or Panamanian (or French, since earlier attempts at a trans-isthmian canal are also considered), had to create and

maintain landscapes conducive to the infrastructure. They came up against numerous problems as they tried to manage the Canal Zone landscapes that provided the canal's water supply. Though much of the watershed had been depopulated as part of the creation of the canal, the swidden agricultural practices preferred by local farmers hurt the watershed's ability to recharge the canal by removing foliage on a large scale. In this reading, machetes indirectly threatened vessels. Balancing local and shipping concerns created conflicts, or paradoxes, and required officials and governments to pick winners and losers. Large networks like the Panama Canal have globalized implications but also intense local ramifications. A waterway that enriches people scattered all over the globe can undermine the means of production on the canal's margins, but also create new economic opportunities; a waterway that permits the easier global transit of goods (approximately 5% of world trade) simultaneously impedes local transportation in some ways while facilitating other types of mobility.

Thus, the Panamanian forests themselves were an integral part of the canal infrastructure. So too did bananas become, as Carse puts it in one of the most fascinating chapters, an "infrastructural species" since they thrive in ecotones like the Canal Zone and their success depended on human labor and transportation infrastructure (133). The creation of stagnant water for the canal also allowed for the proliferation of water hyacinth, a weed that needs constant management or else it can block shipping channels. The water hyacinth illustrates that ways that the technological conquest of nature is contingent and never complete; rather, built infrastructures like the Panama Canal create "demanding environments" that necessitate perennial labor, maintenance, and capital if they are to function as designed. Without upkeep infrastructures can change, break down, sever connections, or return to nature, producing "different experiences of control over or separation from the nonhuman world, while increasing vulnerability to its variability" (220).

Unpacking the concept of "hybridity" is central to *Beyond the Big Ditch*. Water and environmental scholars have been seriously wrestling with notions of hybridity, or its various synonyms, for at least twenty years.[6] In the last decade or so an increasing number of historian have repeatedly pointed to the intertwined natures of technologies and environments, often with an emphasis on transportation and water control infrastructure. These scholars bring in concepts from the history of technology and Science and Technology Studies (STS) which, when combined with environmental history methods, results in what has been labeled as "envirotech" history.[7] Lately there has been a growing number of books by scholars who consciously utilize envirotech and STS,[8] and on several occasions in the last few

[6] Works from the 1990s by the likes of Richard White, Joel Tarr, Martin Melosi, Mark Fiege and Jeffrey Stine can be considered as the vanguard of scholars dissecting hybrid natures.

[7] An Envirotech subgroup (http://www.envirotechweb.org) of the Society for the History of Technology (SHOT) has been in existence since the 1990s, and has meetings at both the annual SHOT and ASEH conferences.

[8] A sampling of recent books by envirotech authors include: Thomas Zeller, *Driving Germany: The*

years the ASEH's George Perkins Marsh Prize has gone to books that have an explicit or implicit envirotech bent (not to mention an emphasis on hybridity).[9] The recent surge of scholarship combining environmental and technological history is well represented in two edited collections: *The Illusory Boundary: Environment and Technology in History* and *New Natures: Joining Environmental History with Science and Technology Studies*.[10] As the endnotes to his book testify, Carse is well acquainted with – and contributes to – the burgeoning and vital envirotech field.

Many environmental historians have detailed the tendency of metropolitan areas to spread their resource tentacles into hinterlands, and *Beyond the Big Ditch* shows that other large built environments, not just cities and urban areas, can do the same thing. A sophisticated consideration of scales and spatiality is brought to bear. To return to the "watershed", this concept was not just geographic, but political, and it was only in the late 20th Century that the watershed emerged, or was imposed, as a political and administrative unit in Panama. As Carse persuasively shows, this was accomplished through state and official map-making. (50) In that vein, the book also examines how the surrounding transportation networks (railways, roads, highways) across and around the canal changed over time. This involves nuanced discussions of mobility, a theme to which other historians working at the

---

Landscape of the German Autobahn, 1930-1970 (New York: Berghahn, 2007); Joy Parr, *Sensing Changes: Technologies, Environments and the Everyday* (Vancouver: UBC Press, 2010); Sara Pritchard, *Confluence: The Nature of Technology and the Remaking of the Rhône* (Cambridge, MA: Harvard University Press, 2011); Finn Arne Jørgensen, *Making a Green Machine: The Infrastructure of Beverage Container Recycling* (New Brunswick, NJ: Rutgers University Press, 2011); Edmund Russell, *Evolutionary History; Uniting History and Biology to Understand Life on Earth* (New York: Cambridge University Press, 2011); Christopher Jones, *Routes of Power: Energy and Modern America* (Cambridge, MA: Harvard University Press, 2014). For what it is worth, this reviewer also self-identifies as a water and envirotech historian: Daniel Macfarlane, "'A Completely Man-Made and Artificial Cataract': The Transnational Manipulation of Niagara Falls," *Environmental History* 18 (4) (October 2013): 759-784; Daniel Macfarlane, *Negotiating a River: Canada, the US, and the Creation of the St. Lawrence Seaway* (Vancouver: UBC Press, 2014).

[9] The most obvious include: Timothy LeCain, *Mass Destruction: The Men and Giant Mines that Wired America and Scarred the Planet* (New Brunswick, NJ: Rutgers University Press, 2010); David Biggs, *Quagmire: Nation-Building and Nature in the Mekong Delta* (Seattle: University of Washington Press, 2012); Daniel Schneider, *Hybrid Nature: Sewage Treatment and the Contradictions of the Industrial Ecosystem* (Cambridge, MA: MIT Press, 2013). In a 2013 state-of-the-field essay, Paul Sutter identified hybridity as a "defining tendency of recent scholarship in American environmental history." Paul S. Sutter, "The World With Us: The State of American Environmental History," *Journal of American History* 100 (1) (2013): 94-119.

[10] Martin Reuss and Stephen H. Cutcliffe, eds., *The Illusory Boundary: Environment and Technology in History* (University of Virginia Press, 2010); Dolly Jørgensen, Finn Arne Jørgensen, and Sara B. Pritchard, eds., *New Natures: Joining Environmental History with Science and Technology Studies* (Pittsburgh: University of Pittsburgh Press, 2013). The introductions and contributions to these edited collections outline the envirotech field, but see also Edmund Russell, James Allison, Thomas Finger, John K. Brown, Brian Balogh, and W. Bernard Carlson, "The Nature of Power: Synthesizing the History of Technology and Environmental History," *Technology and Culture* 52 (April 2011): 246-259; Sara Pritchard, "Toward an Environmental History of Technology," in Andrew C Isenberg, ed., *Oxford Handbook of Environmental History* (New York: Oxford University Press, 2014).

intersection of environmental and transportation history have been paying attention.[11]

However, perhaps because of the anthropological and ethnographic approach that underpins this monograph, some aspects will be, I think, unsatisfying or frustrating for historians. The book is written as if the reader is either already familiar with the key stages and events in the Canal's history, or that they do not matter enough to be explained. The episodic organization of the book strikes me as a significant flaw, as the chapters jump back and forth in time, from past to present, without a clear rationale. An historical overview, or at least a timeline of key events, could have been provided. Chapters 5 and 6 should have been placed before some of the chapters that precede them. I complain about the organization not simply because I am inclined towards a linear narrative, but equally because the withholding of information impedes the reader's understanding of issues, connections, and historical causation.

Maybe I am an idealist, but I would like to think that a key aspect of what separates historians from other fields is that historians should tell a story, and tell it well. The author offers engaging prose, interspersed with interesting personal anecdotes, reflections, and stories, and manages to make what is essentially an extended meditation on water-related infrastructure much less dry, forgive the pun, than it might have been. At the same time, Carse cherry-picks events and processes to analyze, rather than providing a coherent narrative arc. In some ways, this book feels like an edited collection ordered around the theme of environment, technology, and infrastructure at the Panama Canal.

These criticisms may well speak to my disciplinary biases (as an aside, maybe I am guilty of embracing interdisciplinarity until it comes time to package and present research findings). That said, because of this book's approach, my background, and the forum in which this review appears, I am compelled to evaluate it mainly as a work of history. Carse did undertake extensive historical research in archives, to his credit, and it shows. On that note, the brevity of the chapter on the communities dislocated by the canal and its networks felt like a missed opportunity since the envirotechnical process of working out the submersion and relocations of "lost villages" for other similar megaprojects (e.g., Tennessee Valley Authority, St. Lawrence Seaway and Power Project, Columbia River hydro developments) has proven to be extremely revealing.

---

[11] See the December 2014 special edition of *The Journal of Transport History* on the environmental histories of transportation (http://www.ingentaconnect.com/content/manup/jtth). There is also a forthcoming edited collection on the connections between environmental and mobility history in the Canadian context, to which this reviewer has contributed a chapter about the St. Lawrence Seaway and Power Project: Ben Bradley, Colin Coates, and Jay Young, eds., *Moving Natures: Mobility and Environment in Canada History* (Calgary: NiCHE-University of Calgary Press Environmental History Series, forthcoming).

My criticisms should not obscure the fact that I think there are important ideas on offer. The elucidation of the ways that infrastructures produce environments, and vice versa, is compelling. Carse's stress on materiality and networks at varying scales helps obviate the problem of (literally in this case) obscuring the forest for the trees when it comes to large infrastructures. Perhaps the greatest value of *Beyond the Big* is that it is a powerful assertion of the need to historicize the intertwined natures of the state, environments, and transportation infrastructure networks. Carse demonstrates that infrastructure is not a static artifact or system, but a continually negotiated relationship with both social and environmental consequences. These ideas, along with the notion of "demanding environments," can be profitably incorporated by water and transportation historians, as well as envirotech and STS scholars. Energy history also strikes me as a prime example of where more nuanced applications of technological and transportation history would be beneficial.

Finally, the Panama Canal serves as a cautionary tale for analogous projects such as the impending Nicaragua inter-oceanic canal: in addition to the obvious and enormous environmental and social costs, the perennial upkeep and reach of the infrastructure will be more demanding than planners realize.[12]

[12]http://e360.yale.edu/feature/nicaragua_canal_a_giant_project_with_huge_environmental_costs/2871/

Response by Ashley Carse, Vanderbilt University

As authors tell anyone willing to listen, writing is a solitary affair. I knew that. But I imagined that my book's publication date would be different—that, after years of work, it would enter the world with a bang. A week before that anticipated day, Halloween 2014, I was sitting on a bench on the University of Virginia campus with a senior colleague. It was a golden fall afternoon in Charlottesville and our conversation drifted from the lecture he had just given, to the vagaries of the academic job market, to what was really on my mind then: first books. I told him how excited I was that my book would be "out" soon.

"This is the quiet before the quiet," he laughed, explaining that his book, published three years before, was still being reviewed in journals—a testament to the delayed gratification (or dismay) of seeing others engage work that one has lived with for so long. What's more, we rarely have an opportunity to respond to our readers' critiques, challenges, questions, and, hopefully, compliments in print. It is with great satisfaction and sincere gratitude, then, that I sit down a year later to engage with a set of reviews that demonstrate a careful reading of my book's arguments and empirical material, all offered in a generous spirit.

With that said, I would like to begin by thanking Chris Jones for organizing this roundtable and bringing together an outstanding group of reviewers who have written or are writing about canals in Canada, France, Panama, and the United States. I also want to thank each of them for their thoughtful and generative comments. What a pleasure it is to be in dialogue with these scholars at a moment when old dreams about canals and national development have been dredged up once more through major expansion projects on the isthmuses of Suez and Panama and the proposed construction of a canal across Nicaragua.

The research for this book began in 2006 as a dissertation project about the management of the Panama Canal watershed. The watershed is a large hydrologic basin (around 1100 square miles) drained by six major rivers that provide the enormous volume of fresh water that the lock canal requires to operate.[13] Since the 1970s, the Panama Canal Authority and a number of other institutions have managed the forests of the watershed as a form of natural infrastructure in order to optimize the water supply available for shipping, especially during droughts.[14] My

[13] The canal flushes fifty-two million gallons of fresh water out to sea per transit. According to the Panama Canal Authority's Annual Report, there were 13,481 transits in the 2014 fiscal year, or 37 per day. Therefore, a crude calculation suggests that the canal uses nearly two billion gallons of fresh water per day on average.

[14] The term natural infrastructure was not used when Panama Canal watershed management began in the early 1980s, but, even then, watershed forests were described using technological metaphors like factory and machine, often with an emphasis on water "production." More recently, the language of infrastructure has been used explicitly in Panama and beyond. For example, The Economist has characterized Panama's forests as infrastructure to make a case for assigning a monetary value to ecosystem services: "Planting forests around the Panama Canal would have the

graduate training is in anthropology and the research was shaped by the discipline's commitment to long-term ethnographic fieldwork. I lived and worked in two communities discussed in the book (Boquerón and Limón) and conducted interviews with development, environmental management, and agriculture professionals.

I did not set out to write an environmental history of the Panama Canal, so it is an unexpected pleasure that scholars in the field have taken an interest in *Beyond the Big Ditch*. When asked about my research, I often say that I backed into the canal. I went to the isthmus to study a conflict that I thought was about forests, but rural Panamanians showed me that it was actually about the construction, maintenance, and abandonment of infrastructures. The book develops and expands that ethnographic insight. It combines anthropological and historical research to examine the emergence of an environmental conflict at the intersection of two competing infrastructures around the canal: interoceanic transportation and rural development. The first section (*Headwaters*) examines how anxiety about drought and water supply in the 1970s and 1980s motivated the canal administration and Panamanian state to manage land cover in the surrounding watershed for water storage and conveyance purposes. The conflict that ensued turned on a cultural landscape. For farmers, secondary vegetation was *rastrojo* (fallow) and managed as part of their swidden agricultural system. For canal administrators, that same land cover was forest necessary to "produce" fresh water for shipping. The book's second section (*Floodplains*) and third section (*Interior*) retrace the different paths that led canal administrators and campesinos to the upper Chagres River and brought their land use practices into tension. The final section (*Weeds*) reflects on the environmental politics of infrastructure and challenges of managing a technical system and socioecology together.

Playing with the language of water, Mukerji describes infrastructural development as coming in waves that "can overlap and contradict" or as "storms that uproot lives." Canal construction was like a decade-long tsunami that left the landscape littered with new populations, institutions, languages, and engineered systems. That was not the first big wave. It followed Spanish colonial roads, the Americas' first interoceanic railroad, and a failed French canal project. Nor was it the last. The US government built more imperial infrastructure and flooded the isthmus with foreign laborers and soldiers during the Second World War. Even then, the Panamanian government, supported by international institutions, was assembling its own infrastructure to

---

same effect as building vast reservoirs and filtration beds. Viewed in this way, any scheme to reforest the canal's watershed is, in fact, an investment in infrastructure." The quote appears in "Are You Being Served? Environmental Entries Are Starting to Appear on the Balance Sheet. Perhaps Soon, the Best Things in Life Will Not Be Free," *The Economist* (Panama City, 2005). I have written about this phenomenon in detail elsewhere. See Ashley Carse, "Nature as Infrastructure: Making and Managing the Panama Canal Watershed," *Social Studies of Science* 42, no. 4 (2012): 539–563.

modernize the nation's rural interior. Soon, other waves—anti-imperialist and socialist—came from the South. Agrarian reform and colonization washed over the landscape, replacing forests with roads, cooperatives, and pastures. Attention to overlapping waves of infrastructural development shows, as Mukerji observes, "that modernization is not simple or singular, and that economic development is not linear." Nor was it everything. The canal ran through many lives and landscapes, but it did not define them. As the waves came and went, everyday life persisted. People worked and raised families, loved and quarreled, and went to churches and bars.

As Lasso explains in her review, Panama Canal scholarship is substantial in volume and surprisingly narrow in focus. It has long been dominated by triumphalist accounts of the 1904-1914 US construction era. Historians have increasingly revised that narrative on political and social grounds by analyzing imperialism and foregrounding the experiences of marginalized groups. Nevertheless, one foundational assumption has remained intact. When it comes to the environment, triumphalists and their critics alike tend to frame the opening of the waterway as a technoscientific conquest of nature (i.e., the *end* of a struggle against earth and disease-carrying mosquitoes) rather than what it actually was: the *beginning* of an ongoing social and environmental management project.[15] The "Beyond" in the book's title gestures to this expansive approach to the canal—and by extension infrastructure—at the levels of historiography, theory, and geography. Lasso was pleased by my effort to cross the historiographical boundaries that divide the canal from the Republic of Panama and those that partition the isthmus into agricultural, forest, and transport regions. Nevertheless, she wishes that I had discussed one zone more: the city. Her comment provides an opportunity to discuss theories of space and scale in the book.

Infrastructure Space

Beyond the Big Ditch has a rural emphasis. Large parts of the book discuss the historical experiences of the residents of small Panamanian communities, but it is not only about them. A great deal of "urban" history is just beneath the surface. At the level of spatial theory, I was, as several reviewers noted, drawing on an

[15] This argument is detailed in Ashley Carse and Christine Keiner, "Panama Canal Forum Introduction: From the Conquest of Nature to the Construction of New Ecologies," *Environmental History* (In press). It builds on a small but growing environmental history and social science literature. See the following and other work by these authors: Guillermo Castro Herrera, *El Agua Entre Los Mares* (Panama City: Ciudad de Saber, 2007); Stephen Frenkel, "Geographical Representations of the 'Other': The Landscape of the Panama Canal Zone," *Journal of Historical Geography* 28, no. 1 (2002): 85–99; Stanley Heckadon-Moreno, "Light and Shadows in the Management of the Panama Canal Watershed," in *The Rio Chagres: A Multidisciplinary Perspective of a Tropical River Basin*, ed. Russell S Harmon (New York: Kluwer Academic/Plenum Publishing, 2005), 28–44; Eben Kirksey, *Emergent Ecologies* (Durham, NC: Duke University Press, 2015); Megan Raby, "Ark and Archive: Making a Place for Long-Term Research on Barro Colorado Island, Panama," *Isis* 106, no. 4 (2015); Paul S Sutter, "Nature's Agents or Agents of Empire? Entomological Workers and Environmental Change during the Construction of the Panama Canal," *Isis* 98, no. 4 (2007): 724–754; Omar Jaen Suarez, *Hombres Y Ecología En Panamá* (Panamá: Editorial Universitaria, Smithsonian Tropical Research Institute, 1981).

interdisciplinary body of research on infrastructures as lines of territorial power that blur the boundaries between city and country as well as state and society.[16] By focusing on the interoceanic canal and regional road systems as entangled connective tissues, I hoped to show how even small rural communities like Boquerón and Limón have long been linked to Panamanian cities and the world beyond through colonial and imperial networks, state institutions and projects, wage labor migration, and commodity markets. Lasso's comment about the lack of urban history focuses on my chapter on the *transistmica* highway. She notes that both US Zonians and urban middle-class Panamanians drove on the road. This is true, but that specific omission reflects the chapter's limited scope, rather than a lack of interest in urban Panama. My main goal in the chapter is to show the symbolic and material role of road building in efforts to integrate Panama's cities and rural interior in the first half of the twentieth century, as well as illustrating the larger point that Lasso highlights: the canal divided, even as it united.

One of the book's general lessons is that we might move away from framing environmental conflicts as local versus global. In canal scholarship, the US project is often considered global and modern while its rural Panamanian neighbors are considered local and backward.[17] This notion is replicated in environmental discourses that naturalize the environmental demands of "global" infrastructure projects in ways that assume their inevitability (e.g., Panama's destiny or "geographic vocation" as a transportation service provider) while characterizing some "local" uses of the environment as problematic and subject to change. Neither category holds up to scrutiny. The canal could be characterized as local because its operation depends on ten thousand workers, engineered systems, and river water, to name only a few examples. By the same token, campesinos could be called global actors because their choices about where to live and how to use the land are bound up with transnational networks of institutions, capital, and expertise. I argue that an analytical and empirical focus on competing global infrastructures may be more useful.

What are we talking about when we talk about global infrastructures?[18] To be clear, I am neither referring to globalization making the world "flat" in terms of economic

---

[16] On the urban/rural divide, see William Cronon, *Nature's Metropolis: Chicago and the Great West* (New York: W.W. Norton & Company, 1991); On the state as a territorial entity, see Chandra Mukerji, "Intelligent Uses of Engineering and the Legitimacy of State Power," *Technology and Culture* 44, no. 4 (2003): 655–76.

[17] Lasso's work on US state efforts to depopulate the Canal Zone and resettle the modern Panamanian and West Indian communities glossed as "natives" is a key part of this effort, see "From Citizens to 'Natives': Tropical Politics of Depopulation at the Panama Canal Zone," *Environmental History* (forthcoming).

[18] There is a growing body of literature on infrastructure in the history of technology, science and technology studies (STS), anthropology, and geography. In the history of technology, the seminal work is Thomas Hughes on sociotechnical systems. In my work, I have been inspired by the work of STS scholars Geoff Bowker, Paul Edwards, and Susan Leigh Star. For a useful analysis of infrastructure and scale, see Paul N. Edwards. 2003. Infrastructure and Modernity: Force, Time, and

competition[19] nor to the structure of an all-encompassing modern world system.[20] From transportation networks to the internet, scholarship on global infrastructure extends historian of technology Thomas Hughes's concept of the sociotechnical system by emphasizing how multiple systems with different builders, boundaries, and developmental histories come to work together via technical connection standards.[21] In a spatial sense, global infrastructures can be imagined as zones (or archipelagoes) of linked systems that cross national borders.[22] Seen through the lens of infrastructure, economic globalization is neither monolithic nor irreversible: it involves new connections and the disconnection of formerly developed places.[23] There are no obvious "system builders" in control. Rather, power operates through faceless bureaucracies like the International Organization for Standardization and the minutiae of trade agreements. Standards are typically treated as politically neutral, but they always have a politics, an economics, and an ethics.[24] Transportation infrastructures are an iconic illustration of this argument. Organized around technical standards like the shipping container and social technologies like industry deregulation, global intermodal transportation has decimated organized labor as governments roll back protections and benefits to attract firms, jobs, and revenues.[25]

Infrastructures are useful for thinking across scales. "To be modern," as Paul Edwards writes, "is to live within and by means of infrastructures, and therefore to inhabit, uneasily, the intersection of these multiple scales."[26] In fact, the "same" infrastructure may be manifest in different ways across spatial and temporal scales, depending on how different groups of people frame and organize around it. As the book shows, convincing farmers to manage their small plots in relation to a watershed region that is administered by the state to provide the water that enables

---

Social Organization in the History of Sociotechnical Systems. In T. J. Misa, P. Brey, & A. Feenberg (Eds.), *Modernity and Technology* (pp. 185–226). Cambridge: MIT Press

[19] Thomas L. Friedman, *The World Is Flat* (New York: Farrar, Straus and Giroux, 2005).

[20] Immanuel Wallerstein, *The Modern World-System* (New York: Academic Press, 1974).

[21] For an overview of sociotechnical systems, see Thomas P Hughes, "The Evolution of Large Technological Systems," in *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, ed. Thomas P. Hughes Wiebe E. Bijker and Trevor Pinch (Cambridge: MIT Press, 1987), 51–82. For an explanation of how attention to infrastructure extends Hughes's concept, see Paul N Edwards et al., *Understanding Infrastructure: Dynamics, Tensions, and Design*, 2007.

[22] Andrew Barry, "Technological Zones," *European Journal of Social Theory* 9, no. 2 (2006): 239–253.

[23] James Ferguson, *Expectations of Modernity: Myths and Meanings of Urban Life on the Zambian Copperbelt* (Berkeley: University of California Press, 2006), 239

[24] Geoffrey C and Susan Leigh Star Bowker, *Sorting Things Out: Classification and Its* Consequences (Cambridge: MIT Press, 1999); Lawrence Busch, Standards: Recipes for Reality (Cambridge: MIT Press, 2011); Martha and Susan Leigh Star Lampland, "Standards and Their Stories: How Quantifying, Classifying, and Formalizing Practices Shape Everyday Life" (Ithaca: Cornell University Press, 2009).

[25] Deborah Cowen, *The Deadly Life of Logistics* (Minneapolis: University of Minnesota Press, 2014).

[26] Paul N Edwards, "Infrastructure and Modernity: Force, Time, and Social Organization in the History of Sociotechnical Systems," in *Modernity and Technology*, ed. Thomas J. Misa, Philip Brey, and Andrew Feenberg (Cambridge: MIT Press, 2003), 186.

the interoceanic passage of massive ships traveling around the planet is emblematic of the multi-scale organizational work involved in global connection. Conflicts can erupt around efforts to align these scale-making projects with one another because one person's infrastructure is, to paraphrase Susan Leigh Star, another's problem.[27] With that in mind, let's turn to the landscapes that may become sites of conflict.

The Forest Multiple

I loved Mukerji's final provocation: where is the forest? She writes, "But what I miss in this book is the forest. It always remains hovering at the edge of the stories of infrastructure that the author tells." I take her point to be that by emphasizing how forests have been shaped by projects like farming, logging, and mining, I downplay their ecological richness and active role in human affairs. This elegant comment points to several key concerns in the book, so I will respond first at the level of historical specificity and then theory.

In foregrounding the human histories of forests around the Panama Canal, I was writing against a declensionist narrative that posits the linear deforestation of the watershed since the mid-twentieth century. Actors using the narrative to rationalize interventions often use forest cover area in the early 1950s (when an early map was made) as the baseline for land cover change. This starting point elides prior centuries of human activity, the dramatic environmental transformations associated with canal construction, and subsequent reforestation due to a US government depopulation policy in the rural Canal Zone. Due to this policy, large areas mapped in the 1950s were not primary forest, but secondary growth that followed enclosure. This distinction is important because the watershed management narrative implied—incorrectly— that campesinos were the first to deforest the area around the Chagres River. Mukerji's comment about forests also raises theoretical issues.[28]

Beyond the Big Ditch is influenced by posthumanist scholarship, including actor-network theory, feminist science studies, and anthropological semiotics. My approach to infrastructure and environment is shaped by the emphasis on relational ontologies that runs through some of this work. Put simply, this is the philosophical position that things of all kinds (technologies, diseases, canals, forests) are effects of bundles of relationships as opposed to the position that they are concrete entities perceived in different ways.[29] As Annemarie Mol, a science and technology studies

---

[27] Susan Leigh Star, "The Ethnography of Infrastructure," *American Behavioral Scientist* 43, no. 3 (1999): 380.

[28] This seems like a good point to flag my intention with regard to the use of theory in the book. With the exception of the introduction chapter, I worked to (mostly) integrate the theory into writing, analysis, and organization. To that end, many of the theoretical references and discussions are confined to the endnotes.

[29] For actor-network theory, see, e.g., Bruno Latour, *Reassembling the Social: An Introduction to Actor-Network-Theory* (Oxford: Oxford University Press, 2005). From feminist science studies, see Donna Haraway, *The Companion Species Manifesto: Dogs, People, and Significant Otherness* (Chicago: Prickly Paradigm Press, 2003). Both Latour and Haraway works draw on the pragmatist philosopher and mathematician Alfred North Whitehead. For an anthropological semiotics influenced by the

scholar, put it in her book *The Body Multiple*, "*ontology* is not given in the order of things…*ontologies* are brought into being, sustained, or allowed to wither away in common day-to-day sociomaterial practices."[30]

What is a forest? And, also, when and with whom is a forest? Conceptualized in terms of relational ontology, the forest is multiple. The secondary vegetation that concerns me in the book is not simply the same "forest" perceived differently by two human groups with competing interests. Rather, different landscapes are *enacted* in relation to infrastructures, institutions, forms of knowledge, values, and practices. This is more than a philosophical debate. It raises practical questions for environmental management.[31] In the book, for example, I discuss the friction between two versions of land cover in terms of temporality: the multi-year fallow cycle of swidden agriculture versus the fixed stands of natural infrastructure protected to store canal water. It is not that one is good and the other bad. They are material manifestations of different values and visions of economic development.

Most of the book's chapters emphasize infrastructure, power, and environmental control, as Mukerji suggests. However, my emphasis shifts toward the end. The last three chapters link the stories of a crumbling rural road and a water hyacinth invasion to the concept of demanding environments, which highlights the limits of infrastructure and importance of maintenance in the face of environmental processes. As campesino farmers will point out, plants quickly colonize clearings. In Panama, succession can advance rapidly with some tree species growing from seedling to a hundred feet tall in fifteen years, at which point primary and secondary forest are indistinguishable in satellite imagery. Within twenty years, a forest canopy can cover recently cultivated land.[32] The Panama Canal Authority can manage the threat that hyacinth poses—choking the shipping lane—but that project can never be complete, because the canal produces the ecological conditions for the hyacinth's success. The campesino farmer also spends a great deal of time weeding. At a certain level of abstraction, then, canal administrators and campesinos are not so different: they manage environments to enact certain potentialities and suppress others. With forest canopies and weeds in mind, let's turn to how my book fits into the field of environmental history.

---

philosopher Charles Sanders Peirce, see Eduardo Kohn, *How Forests Think: Toward an Anthropology Beyond the Human* (Berkeley: University of California Press, 2013).

[30] Annemarie Mol, *The Body Multiple: Ontology in Medical Practice* (Durham: Duke University Press, 2002), 6. The italics are her emphasis.

[31] For a compelling analysis of competing enactments of the environment in a controversy that also draws on Annemarie Mol's work and relational ontology, see Dolly Jørgensen, "Environmentalists on Both Sides: Enactments in the California Rigs-to-Reefs Debate," in *New Natures: Joining Environmental History with Science and Technology Studies* (PIttsburgh: University of PIttsburgh Press, 2013), 51–68.

[32] Stuart Joseph Wright and Mirna Julieta Samaniego, "Historical, Demographic, and Economic Correlates of Land-Use Change in the Republic of Panama," *Ecology and Society* 13, no. 2 (2008).

Environmental history: How big is the canopy?

Greene and Macfarlane situate my book in environmental history and the literature on environment and technology, or envirotech.[33] In addition to kind words about the work's contributions related to infrastructure and environment, Greene highlights the book's treatment of mobility and Macfarlane emphasizes its arguments about scale and the state. Moreover, they both comment on the non-chronological chapter organization (couching it in relation to my training as an anthropologist), but reach different conclusions. For Greene, the organization works; it is appropriate for my research orientation and mimics the flow of water, revealing "a sequence of sources, results, and unintended consequences." Macfarlane, by contrast, criticizes the organization as episodic and a significant flaw. He writes, "However, perhaps because of the anthropological and ethnographic approach that underpins this monograph, some aspects will be, I think, unsatisfying or frustrating for historians. The book is written as if the reader is either already familiar with the key stages and events in the Canal's history, or that they do not matter enough to be explained." To his credit, Macfarlane acknowledges that his critique is explicitly disciplinary and observes that the evaluation of research findings is a challenging aspect of interdisciplinarity.

Environmental history is an expanding field that has the good fortune of attracting scholars from a variety of disciplines. As the number who gather under its canopy further diversify in terms of geographical focus and disciplinary background, tensions will no doubt emerge around differences in methodology, epistemology, and narrative style. *Beyond the Big Ditch* is a work of environmental history, but I was trained as an anthropologist. The book's interdisciplinary approach reflects my intellectual trajectory and the questions I was trying to answer in my research. It is true that certain aspects of the book do not follow the conventions of a historical monograph (though many others do). Rather than responding in depth to each of Macfarlane's points, I would like to use his critique of the book and reflection on interdisciplinary work as an opportunity to consider the broader tensions between environmental history as a subfield of the discipline of history versus a broader intellectual canopy for scholars interested in people and the environment over time. What are we talking about when we talk about environmental history? According to which (or whose) standards should environmental history scholarship be evaluated? These are not questions that I can or should answer, but I want to use the reviews to reflect on them.

As Paul Sutter observed a decade ago, world regions have distinctive environmental history traditions shaped by diverse concerns, sociopolitical contexts, and methodologies.[34] Thus, he asks, "What can US environmental historians learn from non-US environmental historiography?" Sutter highlights themes and approaches understated in North American scholarship a decade ago (the field has diversified

[33] See both Greene's review and Macfarlane's review for summaries of the field and key references.

[34] Paul Sutter, "What Can US Environmental Historians Learn from Non-US Environmental Historiography?," *Environmental History* 8, no. 1 (2003): 109–129.

geographically since then), particularly the different ways the environment articulates with colonial and imperial projects. Looking to South Asia, for example, he calls for attention to marginality, subaltern critiques, and complex state-peasant relationships. He also points out that, globally, environmental narratives have been deployed in sociopolitical contexts very different from North America.[35] Finally, Sutter notes that historians' methods and sources may differ geographically. In Africanist scholarship, for example, the lack of written documentation has led to more archaeological, scientific, and linguistic methods. Sutter makes the point that methodological heterogeneity is not simply a response to constraints to be avoided if possible. Instead, he argues that the non-documentary methodologies used in African environmental history could be usefully emulated in research on the United States.[36]

If there is heterogeneity among historians of the environment, there is even more outside of the discipline. In a review of Latin American scholarship, Mark Carey expands Sutter's observation by emphasizing that non-historians have done environmental history by other names for decades. He asks, "What can environmental historians learn from non-historians doing Latin American environmental history?"[37] Anthropology and geography, in particular, have long traditions of studying ecological and landscape change in places with different research conditions, methods, and political priorities. For example, many historical anthropologists are committed to presenting multiple and often competing historical memories and claims. Thus, Jean and John Comaroff argue that historical anthropology "must begin by constructing its own archive" because archival, documentary, and literary traces of marginalized human groups are often limited and, when available, reproduce "the culture of global modernism" and obscure endogenous histories.[38] As environmental historians know, non-human actors and environmental processes can also be difficult to retrace through documentary sources alone. Thus, historical ecologists use methods ranging from palynology to oral history to understand landscape change across spatial and temporal scales.[39] My point is that some places, peoples, times, and ecologies may demand different kinds of methods and that some stories require different voices.

---

[35] Rather than a tool of the progressive conservation movement against capital and industry, narratives of environmental decline have bee used by colonial and postcolonial powers to dispossess smallholders from the land. This is a key theme in the political ecology of conservation literature. See, e.g., James Fairhead and Melissa Leach, *Misreading the African Landscape: Society and Ecology in a Forest-Savanna Mosaic* (Cambridge: Cambridge University Press, 1996).

[36] Sutter, "What Can US Environmental Historians Learn from Non-US Environmental Historiography?," 117.

[37] Mark Carey, "Latin American Environmental History: Current Trends, Interdisciplinary Insights, and Future Directions," *Environmental History* 14 (2009): 223.

[38] John Comaroff and Jean Comaroff, *Ethnography and the Historical Imagination* (Boulder: Westview Press, 1992), 34.

[39] Carole L Crumley, "Historical Ecology: Integrated Thinking at Multiple Temporal and Spatial Scales," in *The World System and The Earth System: Global Socio-Environmental Change and Sustainability Since the Neolithic*, ed. Alf Hornborg and Carole Crumley (Walnut Creek: Left Coast Press, 2007), 15–28.

Environmental histories are not natural. They assign human meaning and causality to a more-than-human reality. For me, this means that the best environmental histories are, as Bill Cronon put it, "not just stories about nature, but stories about stories about nature".[40] The temporalities of the non-human world can be linear, but they can also be cyclical or random, not conforming to chronological structure. In terms of human meaning, causality can work—as pragmatist philosophers have long argued[41]—in ways other than past to present. For example, actors in the present continuously revise historical truth and deploy it in ways that have real consequences. Thus, depending on one's theoretical orientation, there are times when it is appropriate to "jump back and forth in time, from past to present," as Macfarlane puts it in his critique. Writing histories of how previously unknown environmental objects are stabilized through sociomaterial practices is illustrative here. In an essay on the historicity of things, Bruno Latour asks, "Were there microbes before Pasteur?"[42] He argues that if we accept a correspondence theory of truth—a statement is true or false to the degree that it corresponds with the world—then microbes have either always been there or never been there; they have no history. If, by contrast, we accept a relational ontology (introduced in the section above), then discovery and measurement change microbes by altering the relations that make them up. "The word 'substance'," Latour writes, "does not designate 'what remains beneath,' impervious to history, but what gathers together a multiplicity of agents into a stable and coherent whole."[43]

An environmental history that brings together events, narratives about those events, and the historicity of water, plants, weather, and earth might conceptualize the relationship between past and present along two axes. The first axis would be what Macfarlane suggests: a linear succession of events, each attached to a specific date or dates. Colonists arrive, a road is built, a treaty is signed, a lake is flooded, and so on. This axis could be adequately captured by what he calls a "timeline of key events" with its implicit emphasis on how the past shapes the present. The second axis would flag the sedimentation of associations around a year or an event over time, tracing how the past is reworked. In the book, for example, I explain how a map of watershed forests created in 1952 was ignored for decades (it had no purpose then), before suddenly becoming useful in relation to emergent anxieties about water scarcity in the late 1970s. At that point, the map was used to establish a regional environmental history that recast 1950s and 1960s modernization efforts as degradation. Together, an old map and a new story altered the region's trajectory. Latour applies the same philosophy to things. He writes, "A lactic acid ferment

---

[40] William Cronon, "A Place for Stories: Nature, History, and Narrative," *The Journal of American History* 78 (1992): 1375.

[41] See, e.g., William James, "What Pragmatism Means," in *Pragmatism: A Reader*, ed. Louis Menand (New York: Vintage Books, 1997 [1904]), 93–111.

[42] Bruno Latour, "The Historicity of Things: Where Were Microbes Before Pasteur?," in *Pandora's Hope: Essays on the Reality of Science Studies* (Cambridge, MA: Harvard University Press, 1999), 145–173.

[43] Latour, "The Historicity of Things," 151.

grown in a culture in Pasteur's lab in 1858 is not the same thing as the residue of an alcoholic fermentation in Liebig's laboratory in Munich in 1852. Why not the same thing? Because it is not made out of the same articles, the same members, the same actors, the same propositions."[44] Or, in the world of my book: the watersheds of 1500, 1904, 1915, 1980 and 2015 are different. A watershed may be a "natural fact," but that is not enough to make it a social reality. My book's organization reflects how regions are made along multiple axes, tracing linear events and the sedimentation of knowledge (surveys, measurements), technologies (dams, maps), and institutions and policies around a geohydrological form.

Infrastructure, Environment, and Life

By way of conclusion, I turn to Greene's sweeping review, which allowed me to see my work in a new light. In the final paragraph, she uses *Beyond the Big Ditch* to ask compelling questions about infrastructure that might generate new research. The questions speak to comparative analysis ("What else is like a canal?"), mobility and environment, modes of evaluation, and evolutionary history. These are all exciting ideas and I look forward to thinking more about each of them. For now, I'll focus on Greene's idea of infrastructures as evolutionary forces. I am neither a biologist nor a historian of science, but a focus on infrastructure and life—rather than carbon or radiation—seems like a compelling entry point for writing histories of the anthropocene. For heuristic purposes, we might think about two types of evolutionary processes potentially associated with infrastructures—within them and around them—recognizing that this is an artificial divide and that most infrastructures are leaky. The first type (within) could include both useful species like the microorganisms built into sewage treatment plants and undesirable ones like the pathogens that have coevolved with industrialized food systems.[45] With regard to waterborne transportation specifically, the biological success of invasive species is, of course, a compelling example of a "within" that becomes an "around." But there are also less recognized environmental transformations that take place around transportation infrastructure. For example, state institutions and private firms actively manage and transform hydroecologies across the planet to attract ships and revenue.

The Panama Canal expansion is a case in point. The six-billion-dollar, decade-long project is expected to be complete in 2016. The canal's expanded locks will allow new generations of massive oceangoing ships to move between the Atlantic Ocean and Pacific Ocean. I see the expansion as a hemispheric environmental standardization event. The expansion links work in Panama to projects along an extensive network of connected ports and waterways. Along the Gulf and Atlantic coasts of North America, port authorities and other institutions are racing to dredge

---

[44] Latour, "The Historicity of Things," 150.

[45] Daniel Schneider, *Hybrid Nature: Sewage Treatment and the Contradictions of the Industrial Ecosystem* (Cambridge, MA: MIT Press, 2011); Chris Otter, "Toxic Foodways: Agro-Food Systems, Emerging Foodborne Pathogens, and Evolutionary History," *Environmental History* 20, no. 4 (2015): 751–764.

their harbor approaches and inland waterways to fifty feet deep (the maximum draft for ships passing through the expanded Panama Canal). Dredging can rework ecologies in ways that mean some species thrive while others struggle. For example, dredging efforts in the Savannah River and Port of Savannah associated with the canal expansion would lead to oxygen depletion. In response to concerns, the Army Corps of Engineers proposed a plan to maintain the ecosystem through twelve oxygen injection machines—life support for fish, mammals, and plants. On a more hopeful note, dredged sediments can be used in ecological restoration projects, like the creation of tidal wetland habitat using material coming from the New York-New Jersey Harbor Deepening Project.[46] This is the barnacled underside of global transportation: the reworking of the world itself to meet infrastructure standards. Environmental history can help us to understand how infrastructures have reshaped environmental politics and maybe even life itself.

[46] Both examples come from a fascinating landscape architecture analysis of the expansion as a transnational environmental event. Brian Davis, Rob Holmes, and Brett Milligan, "Isthmus," *Places Journal* (2015).

About the Contributors

Ashley Carse is Assistant Professor in the Department of Human and Organizational Development at Vanderbilt University. He received his PhD in Anthropology from UNC-Chapel Hill. *Beyond the Big Ditch* is his first book. His website is www.ashleycarse.com.

Ann N. Greene is the author of *Horses at Work: Harnessing Power in Industrializing America* (Harvard, 2008). She teaches environmental and energy history in the History and Sociology of Science Department at the University of Pennsylvania. Her current project is an environmental history of the Erie Canal.

Christopher F. Jones, Assistant Professor in the School of Historical, Philosophical, and Religious Studies at Arizona State University, studies the histories of energy, environment, and technology. He is the author of *Routes of Power: Energy and Modern America* (Harvard, 2014) and is currently working on a project examining the relationships between economic theories of growth and the depletion of non-renewable natural resources in the twentieth century.

Marixa Lasso is Associate Professor of Latin American History at the Universidad Nacional de Colombia. Prior to joining the Universidad Nacional, she was Associate Professor with tenure at Case Western Reserve University. She is the author of the book *Myths of Harmony: Race and Republicanism during the Age of Revolution, Colombia 1795-1831* (2007). Professor Lasso is a contributor to numerous books and has published in journals like the American Historical Review and Citizenship Studies. She is currently working on a book about the depopulation of the Panamanian towns of the Canal Zone, for which she received grants from the American Council of Learned Societies and the National Humanities Center. She has also held fellowships from the Social Science Research Council, Fulbright, and the Werner Gren Foundation. Her work has been translated to Spanish and Portuguese.

Daniel Macfarlane is an Assistant Professor in Environmental and Sustainability Studies at Western Michigan University. His work focuses on the envirotechnical, energy, and environmental diplomacy history of US-Canada border waters, particularly in the Great Lakes-St. Lawrence basin. He is the author of *Negotiating a River: Canada, the US, and the Creation of the St. Lawrence Seaway* and co-editor (with Lynne Heasley) of a forthcoming collection on Canadian-American border waters, and is working on a book about the transnational engineering of Niagara Falls as well as other research projects about the first century of the International Joint Commission; the history of Great Lakes water levels; and the history of Canada-US-Mexico border waters governance.

Chandra Mukerji is Distinguished Emeritus Professor of Communication and Science Studies at UC San Diego. Her research interests include the social and historical dimensions of engineering, infrastructure, state power, cognition, and

communication. She is author of numerous books including *From Graven Images: Patterns of Modern Materialism* (Columbia, 1983), *A Fragile Power: Scientists and the State* (Princeton, 1990), *Territorial Ambitions and the Gardens of Versailles* (Cambridge, 1997), and *Impossible Engineering: Technology and Territoriality on the Canal du Midi* (Princeton, 2009).