

The book cover features a detailed illustration of a large, arched tunnel entrance. At the top, two large, orange, fleshy hands are shown squeezing together, with blue liquid dripping from their fingers. The tunnel's interior is a deep blue, and its walls are lined with numerous small, colorful, and diverse icons representing various aspects of nature, technology, and history. The overall style is artistic and textured, with a focus on environmental and technological themes.

Watering the **REVOLUTION**

AN ENVIRONMENTAL AND
TECHNOLOGICAL HISTORY
OF AGRARIAN REFORM
IN MEXICO

MIKAEL D. WOLFE

Watering the Revolution

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An Environmental and Technological History of
Agrarian Reform in Mexico *Mikael D. Wolfe*

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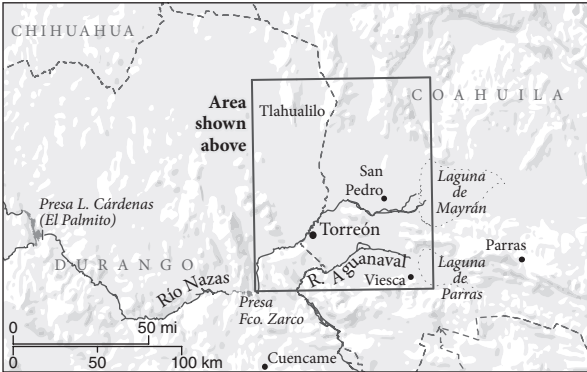
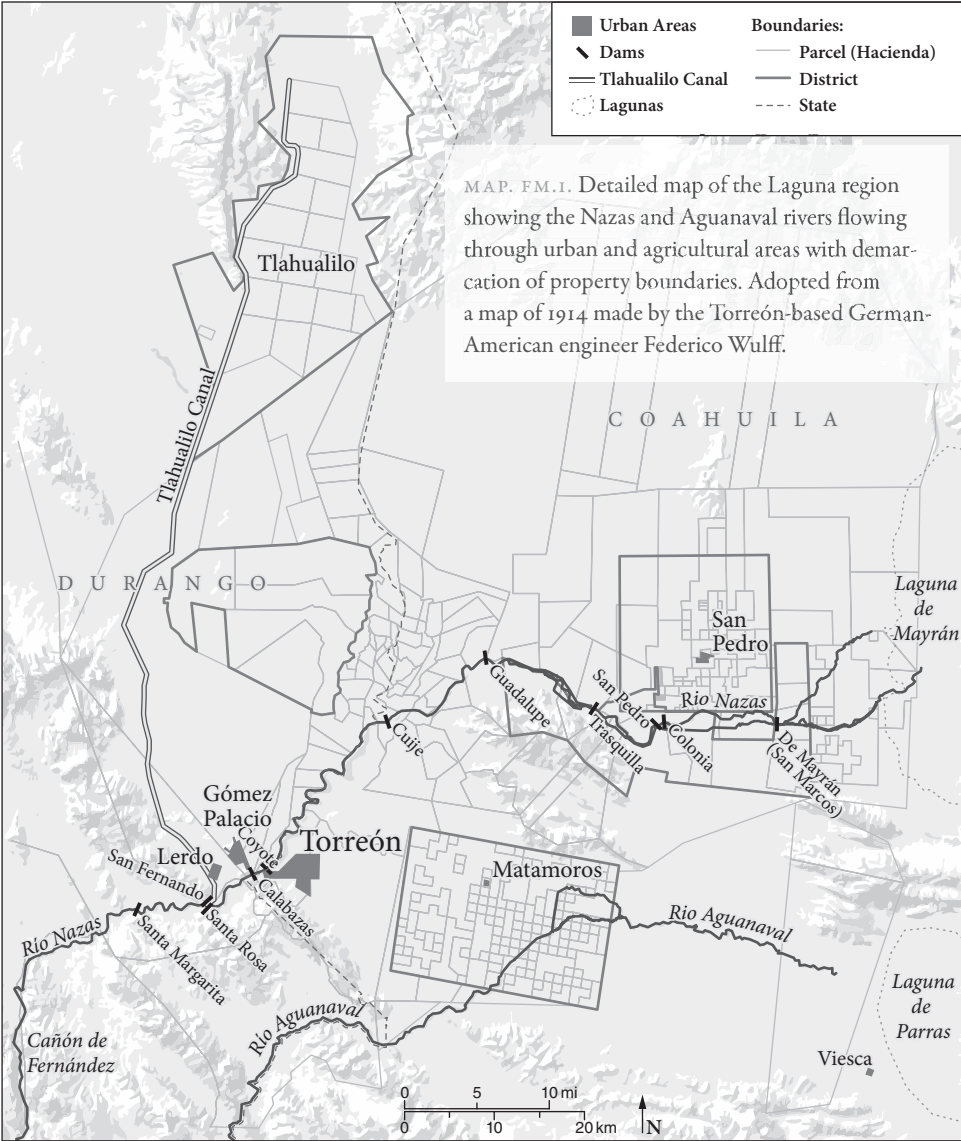
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To my parents



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Abbreviations

AHA	Archivo Histórico del Agua (Historical Water Archive)
CCM	Confederación Campesina Mexicana (Mexican Peasant Confederation)
CEMEX	Cementos Mexicanos (Mexican Cement Company)
CFE	Comisión Federal de Electricidad (Federal Electricity Commission)
CNA	Comisión Nacional del Agua (National Water Commission)
CNC	Confederación Nacional Campesina (National Confederation of Campesinos)
CNI	Comisión Nacional de Irrigación (National Irrigation Commission)
CROM	Confederación Regional Obrera Mexicana (Regional Mexican Labor Confederation)
CTM	Confederación de Trabajadores de México (Workers' Confederation of Mexico)
DDT	Dichlorodiphenyltrichloroethane
GDP	gross domestic product
ISI	import substitution industrialization
LALA	La Laguna Dairy Company
NAFTA	North American Free Trade Agreement

PAN	Partido Acción Nacional (National Action Party)
PNR	Partido Nacional Revolucionario (National Revolutionary Party)
PPACL	Pequeña Propiedad Agrícola de la Comarca Lagunera (Small Landholders of the Laguna Region)
PRD	Partido de la Revolución Democrática (Revolutionary Democratic Party)
PRI	Partido Revolucionario Institucional (Institutional Revolutionary Party)
SAF	Secretaría de Agricultura y Fomento (Ministry of Agriculture and Development)
SAG	Secretaría de Agricultura y Ganadería (Ministry of Agriculture and Livestock)
SEMARNAP	Secretaría de Medio Ambiente, Recursos Naturales y Pesca (Ministry of the Environment, Natural Resources, and Fisheries)
SEMARNAT	Secretaría de Medio Ambiente y Recursos Naturales (Ministry of the Environment and Natural Resources)
SEP	Secretaría de Educación Pública (Ministry of Public Education)
SF	Secretaría de Fomento (Ministry of Industry and Development)
SRH	Secretaría de Recursos Hidráulicos (Ministry of Hydraulic Resources)
UNAM	Universidad Nacional Autónoma de México (National Autonomous University of Mexico)

Introduction

Technology was lacking; from the beginning it was not understood that merely shifting the title to the land could not produce the miracle of greater profits from labor that operated under exactly the same physical, economic, and technological conditions. No serious effort was made to discover what changes in methods and in crops could best overcome the unfavorable conditions in which our agriculture has always existed.

DANIEL COSÍO VILLEGAS, “La crisis de México”

We opened our mouths to say that we didn’t want the plain, that we wanted what was by the river. From the river up to where, through the meadows, the trees called casuarinas are, and the pastures and the good land. Not this tough cow’s hide they call the Plain.

But they didn’t let us say these things. The official hadn’t come to converse with us. He put the papers in our hands and told us,

“Don’t be afraid to have so much land just for yourselves.”

“But the Plain, sir—”

“There are thousands and thousands of plots of land.”

“But there’s no water. There’s not even a mouthful of water.”

JUAN RULFO, *They Gave Us the Land*

This book investigates how people managed their water—via dams, canals, and groundwater pumps—in a great crucible of the Mexican Revolution, the arid north-central Laguna region. In so doing, it demonstrates how Mexican federal engineers, also known as *técnicos*, were not merely passive implementers of large-scale state development schemes such as agrarian reform. Instead, to implement it, they actively mediated knowledge between state and society, identifying what they thought was technologically possible and predicting its

environmental consequences. The book also explains how *técnicos* encountered an intrinsic tension between farmers' insatiable demand for water and the urgency to conserve it. Not only are these two intertwined processes largely overlooked in the literature of postrevolutionary Mexican state formation, but also in Latin American environmental history, Latin American history of technology, and even global development studies. By closely examining how the Mexican state watered one of the world's most extensive agrarian reforms, this book tackles a global question that, of yet, has not been convincingly answered: how and why do governments persistently deploy invasive technologies for development even when they know those technologies are ecologically unsustainable?

The problem of unequal land distribution has been a grand motif throughout Mexican history but especially since the Mexican Revolution and its Magna Carta, the 1917 Constitution, mandated in Article 27 agrarian reform for the entire country. Appropriating the powerful symbolism of the agrarian revolutionary martyr Emiliano Zapata and the battle cry of "land and liberty" his movement made famous during the Revolution, from 1917 to 1992 the post-revolutionary Mexican state distributed nearly half of the country's arable land and 60 percent of its rural property to some thirty thousand *ejidos* (communal land grants worked and managed by state agricultural cooperatives or collectives), and thousands of small private landholders.¹ Yet Article 27 also mandated water distribution and conservation as indispensable to agrarian reform, which the postrevolutionary state pursued by building grand hydraulic infrastructure that rapidly expanded irrigation for agriculture. Accounting for 77 percent of all water used, Mexico's agricultural sector historically has been, and continues to be, the nation's largest water consumer, especially in some of its most productive land: the arid and semi-arid central and northern areas that cover two-thirds of the country.

Nowhere was this dependence on water more pronounced than in the Laguna, the fertile region that straddles the northern states of Durango and Coahuila. Short for Comarca Lagunera, or "region of lakes," the Laguna's relationship to its largest river, the Nazas, is like Egypt's relationship to the Nile—the sustenance for human habitation in the region. Historically, Laguna farmers exploited the Nile of the Laguna's torrential flow through a technically sophisticated flood-farming, or *aniego*, method of irrigation. Their extensive use of the *aniego* method transformed the Laguna into Mexico's leading cotton-producing region by 1900 and the Nazas into one of the nation's most important rivers. Because of the economic and geostrategic value that the cotton-rich Laguna attained during the autocratic rule of Porfirio Díaz, the Porfiriato (1876–1911), the region emerged

as a bloody battleground during the military phase of the Mexican Revolution from 1910 to 1920. Until the advent of motorized groundwater pumping on a large scale and high-dam building in the 1930s and 1940s, aniego was ecologically sustainable but socially inequitable. From the 1950s, an even more water-intensive dairy industry largely led to the demise of aniego via state-sponsored modernization projects, chief among them the lining of earthen canals with concrete. The industry's success culminated with the formation of the LALA (short for "La Laguna Dairy Company") in the 1970s (now Mexico's largest), and with it the old "white gold" of cotton fell to the new white gold of milk.²

Since the late nineteenth century, Laguneros have not only initiated and embraced large-scale change at home; they have also spread it nationally. For instance, the "apostle of democracy" and Lagunero Francisco I. Madero was the first to publicly advocate building a high dam on the Nazas River in 1906. Exactly four years to the day later, in 1910, he would call for something far more dramatic: the revolution that would oust Díaz and sweep him into the presidency. Just as he left Mexico for exile in France, Díaz purportedly remarked, "Madero has unleashed a tiger. Now let's see if he can tame it."³ Unfortunately, Madero was not only unable to tame the tiger; he further provoked political destabilization and social crisis by failing to implement the agrarian reform he had promised and was tragically assassinated barely fifteen months later. Although he shelved the Nazas dam project during his crisis-ridden presidency, it would live on and a quarter-century later, in 1936, become the key technological component—indeed, the "revolutionary" dam—of massive agrarian reform by the far more radical president, Lázaro Cárdenas, in the Laguna.

Cárdenas's progressive reforms of the 1930s, like the dam, were in spirit the progeny of Madero, but their substance and evolution over time bore the imprint of the tiger Madero could not control during the 1910s. In the Laguna, the tiger took the form of two decades' worth of mass-mobilization and unionization of campesinos and workers that culminated in the great agrarian reform of 1936. Yet while ordinary campesinos and workers deserve the greatest share of credit for generating the political will for the reform, Cárdenas assigned the actual execution of it to three hundred técnicos, many of them students. It was they who hastily redistributed 500,000 acres from 226 expropriated cotton and wheat estates to approximately 1,700 small landholders and nearly thirty thousand campesino families in three hundred newly created ejidos—all in a record six weeks, three weeks of which Cárdenas even personally supervised.

Sympathetic American observers, including the journalist Marshall Hail of the *Washington Daily News* (the predecessor of the conservative tabloid *Washington Star News*), called the Cardenista agrarian reform in the Laguna "probably

the most advanced social experiment in the Western Hemisphere.”⁴ The *reparto de tierras* (distribution of the land) was fast and relatively easy. The *reparto de aguas* (distribution of the water) for this new land regime proved to be a far greater technical challenge that was never fully overcome. As a result, it left the majority of reparto beneficiaries to tragically suffer severe contamination of, and unequal access to, scarce and fragile water supplies for decades. An unintended, de facto “water apartheid” regime still exists in the region today, and some local critics refer to the dilemma as an *acuifundio*, or a water-hoarding neo-latifundio, between water haves and have-nots.⁵ The haves are generally private landholders who can afford to install and maintain their own motorized pumps that reach deep down to perennially available but harder-to-access groundwater, pumps whose use the government—pretense aside—has seldom regulated. The have-nots are generally ejidos who are unable to afford pumps in the same quantity and quality. Instead, they must rely on what was supposed to be the technological linchpin of Cárdenas’s agrarian reform in the Laguna: the dam that bears his name. Dedicated in 1946, and named to commemorate the president who decreed the great reparto de tierras exactly ten years before, the dam, since its inauguration, has remained a woefully inadequate solution to the technical challenges of the reparto de aguas. Yet in stark contrast to their unwillingness to enforce restrictions on groundwater use, federal técnicos, like their counterparts throughout the world, have strictly regulated reservoir water over the same period.

Watering the Revolution tells the story of how and why this happened from the late nineteenth century to the late twentieth century and what it means for the present and future. Part I, “El Agua de la Revolución (The Water of the Revolution),” contains three chapters spanning from the late Porfiriato to the end of the long Mexican Revolution (1910–40). Chapter 1 begins with Francisco I. Madero’s ill-fated effort shortly before the Revolution to unite his fellow landowning, riverine Laguneros to lobby the government for a high dam on the Nazas River—a project President Díaz already supported. In the process, it describes the longer-term historical ecology of the Laguna since the colonial period, how land tenure and water rights fit into and affected that ecology through irrigated cotton growing, and the emergence of agrarian reform as a broad process of social, environmental, and technological change during the late Porfiriato and the Revolution. Chapter 2 tells the story of the controversial Nazas River Dam project’s postrevolutionary revival and the burgeoning growth of motorized groundwater pumping, and how, in the 1920s and 1930s, both played an important role in the tumultuous sociopolitical transformation of the region. It details how a shifting kaleidoscope of local and national actors transcended class and political divisions to form coalitions that lobbied for and against the

dam. Chapter 3 reveals the environmentally and technically complex and sociopolitically charged tasks that federal *técnicos* encountered trying to make the 1936 reparto de tierras compatible with the reparto de aguas. Facing a series of difficult tradeoffs, they reengineered the Laguna's irrigation system to rely on an unbuilt dam—and, to their growing alarm, on groundwater pumping they long knew depleted and contaminated the aquifer. The chapter demonstrates how the incompatibility between the two repartos compromised the Cardenista agrarian reform's long-term sustainability even before sociopolitical factors such as endemic corruption and implacable opposition severely weakened and then undermined the reform.

Part II, "The Second Agrarian Reform," composed of three more chapters, continues the story beyond the Cárdenas presidency through the 1970s. Chapter 4 turns to the work and life of *técnicos* and their employees and families—many of them *ejidatarios* (members of ejidos)—on the Nazas River Dam construction site from 1936 to 1946. It describes how the government tried to make the site into an exemplary, though socially stratified, "company town," one with striking parallels to their water-deprived ejidos. Chapter 5 examines the postwar and post-dam transformation of the region's water regime, characterized by a sharply rightward sociopolitical turn in Mexico, severe drought, and profligate use of chemical pesticides and groundwater pumps in the late 1940s and 1950s. As a case study, it focuses on how the politically well-connected *técnico*, former secretary of agriculture (1928–30, 1940–46), and self-styled Zapatista and agrarista Marte R. Gómez helped to facilitate this transformation by creating the U.S. subsidiary Worthington de México in the late 1940s and expanding it into Mexico's largest pump manufacturing company by the 1960s. The company's growth flew in the face of numerous government prohibitions on pumping that began in the 1940s and were meant to stem the crisis of aquifer depletion and contamination—a crisis that Gómez had been fully aware of as agriculture secretary. Chapter 6 tells the paradoxical story of the short-term technical success of the federal government's grand rehabilitation plan for the Laguna in the 1960s and 1970s. It shows how, even while they enthusiastically implemented it, *técnicos* accurately predicted the negative medium- and long-term social and ecological consequences the plan would have on the region.

In the epilogue, I discuss Mexico's current water crisis since President Carlos Salinas de Gortari's controversial revision of Article 27 in 1992 terminated seventy-five years of agrarian reform as sacrosanct national policy. I illustrate how recent debates over damming the Aguanaval River, considered the little sister of the Nazas,⁶ in the 2000s were remarkably similar to those surrounding the Nazas in the 1920s and 1930s—an unfortunate testament to the fact that,

despite the inclusion of environmentalist language in government hydraulic development plans and a greater public awareness of their social and ecological costs, it is a story in need of telling.

Definitions: Envirotech(nical)

What is envirotech history and how is it crucial to understanding the story of the Nazas River Dam project and its broader significance to Mexican, Latin American, and world history? Envirotech history was a natural outgrowth of historians' doing environmental history and history of technology.⁷ In the 1990s, several of them combined their work and formed the single hybrid field of envirotech history. Its premise is that throughout history people have consistently blurred the "illusory boundary" between nature and technology by modifying the former with the latter to create "new natures."⁸ Exemplifying the approach is Timothy Mitchell's description of the Nile before the building of the Aswan High Dam: "The Nile was already as much a technical and social phenomenon as a natural one," its waters "channeled, stored, raised, distributed, and drained by the interaction of mechanical, human, animal, and hydraulic power." He thus remarks, "It would have been difficult in describing these arrangements to say where natural forces ended and technology began, or to draw a line between ingenuity and nature."⁹

Surprisingly, environmental historians and historians of technology of Latin America in general have yet to embrace the premise behind envirotech history. Part of the reason for this may simply be that the two fields emerged more recently in Latin America (in the past two decades) than in Europe and the United States, where they are longer established. Another possible reason is the legacy of European and U.S. imperialism for Latin American historiography, which perpetuated a narrative that technology was "imported magic" unsuited to the "backward" conditions of the region's society, culture, and environment.¹⁰ Technology, in that narrative, therefore appeared foreign to both Latin American peoples and their environments. While Latin American historiography definitively revised and repudiated this imperialist narrative decades ago, the illusory boundary between nature and technology that the narrative presupposed generally persists. To be sure, environmental historians and historians of technology of Latin America acknowledge and cite each other's works, but generally they have yet to fully engage with, much less incorporate, each other's foci and methodologies.¹¹

This book, the first such envirotech history of agrarian reform in Mexico, aims to fully integrate the two. It shows that by the late nineteenth century the

Laguna's system of small diversion dams, dikes, and canals, all of which were designed to serve human agricultural needs, also created artificial oases of nutrient-rich waterways that became important habitat on which local flora and fauna depended. Envirotech, and especially the adjective "envirotechnical" that I use throughout this book, thus denotes an interdependence between human ingenuity and nonhuman nature in this relatively sustainable hybrid ecosystem. By interdependence, however, I do not mean that the technology people deployed to modify natural processes was ecologically harmonious or functioned sustainably—although proponents of technological progress argued (and still do) precisely this, especially in the case of dams.

Like their European and American counterparts whom they sought to emulate, creole and then Mexican *técnicos* have been among the most conspicuous proponents of technological progress since the late eighteenth century. Indeed, their education and professional training focused largely on acquiring the theoretical and practical skills to develop and deploy technology to "improve" nature, often by subduing or conquering it, for human use.¹² For example, in a speech to the Association of Mexican Engineers and Architects in 1938, at the height of radical Cardenismo, the Comisión Nacional de Irrigación (National Irrigation Commission; CNI) engineer César Jiménez—much as his predecessors had going back centuries—proclaimed:

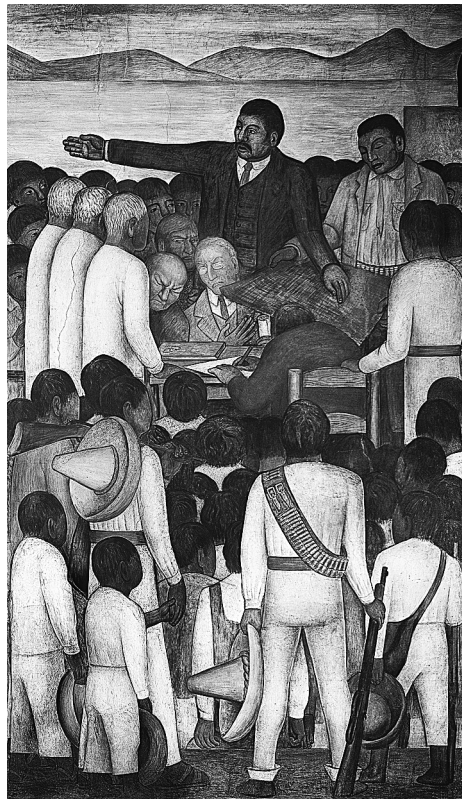
The struggle against nature is a matter of life in Mexico, and it is precisely for this reason that it is absolutely necessary to count on capable men to dominate nature, in other words, engineers. . . . The development of this country is in the hands of engineers. The country needs engineers in all the senses of the word; not simply virtuoso or accredited engineers, but engineering men [*ingenieros-hombres*], instilled with the idea of professional and social responsibility that directs all efforts, sacrifices, and energies into the gigantic task with which they are entrusted for the building of a Grand Mexico.¹³

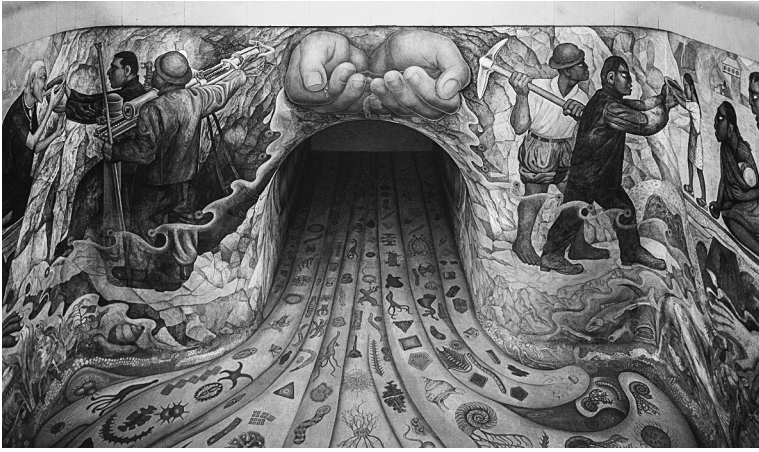
The CNI's logo visually expressed his sentiments: a large dam with an eagle and a serpent above the boldfaced motto "Por la grandeza de México" (For the grandeur of Mexico). In that same year, the logo also appeared in a mural sponsored by the CNI that was exhibited at an agricultural fair, which portrayed *técnicos* and *campesinos* patriotically partnering to build a large dam (see figure Intro.1). It was thematically similar to the contemporaneous murals of Diego Rivera, who celebrated motifs of putative harmony among humanity, nature, and technology, depicting *técnicos* adroitly executing land distribution *and* installing hydraulic infrastructure (see figures Intro.2–4).

FIG. INTRO.1 A hydraulic engineer, facing the viewer with blueprint scroll in hand, and a campesino, with face unseen and back toward the viewer, shake hands on top of a dam under construction. Bringing the two together behind them is the Mexican Angel of Independence. *Irrigación en México* 18, no. 3 (November–December 1938).



FIG. INTRO.2 An engineer and representative of the revolutionary government, pointing to and holding a land survey, explain how the land will be redistributed to armed campesinos gathered around them. Diego Rivera (1886–1957) at Artists Right Society, New York. *Distribución de la Tierra* (Dotación de Ejidos o Reparto de la tierra). 1923–1928. Center panel, part of three connected panels, 4.15 m × 2.38 m; 4.15 m × 2.38 m; 4.15 m × 2.35 m, detail. Court of Fiestas, Level 1, South Wall (Secretaría de Educación Pública 105–6). Courtesy of Schalkwijk/Art Resource, New York.





FIGS. INTRO.3–INTRO.4 (*top*) The Hands of Nature offer water for the building of the Lerma hydraulic works that brought water outside of Mexico City into the city. An engineer drills through the bedrock while two government representatives provide water to thirsty residents. (*bottom*) On the other side of the mural, painted on the actual basin through which water flowed into the pumping sump regulated by several doorways, Rivera positively and optimistically depicts the engineers and architects who designed the grand hydraulic work. Diego Rivera (1886–1957) at Artists Right Society, New York. *Water, Origin of Life* (Water reservoir), 1951. Fresco in polystyrene and rubber solution. Courtesy of Schalkwijk/Art Resource, New York

By featuring *técnicos* so prominently, these and other muralists of the time highlighted the human agency behind technological progress. They even intuitively grasped Merritt Roe Smith and Leo Marx's nuanced analysis of technological determinism in their influential edited volume *Does Technology Drive History?*: "Once [a technology] has been developed, its determinative efficacy may then become sufficient to direct the course of events. . . . In that case technological determinism has been redefined: it now refers to the human tendency to create the kind of society that invests technologies with enough power to drive history."¹⁴ In addition, the kind of society that *técnicos* sought to create—or re-create, as it were—varied according to the unique circumstances of their countries, and regions within them, during the time they worked.

Superficially, postrevolutionary Mexico seemingly epitomized the "high modernist" authoritarian state, able and willing to impose its developmental schemes on a "prostrate" civil society, with tragic, unintended consequences. In his seminal work *Seeing Like a State*, James C. Scott argues that this dynamic occurred not only in the Soviet Union but also in Brazil, Tanzania, and other places, and in each case engineers generally appear as unquestioning executors of state blueprints for remaking nature and society into "legible" subjects of rule.¹⁵ But this was not the case in "soft authoritarian" Mexico, something Scott himself acknowledged several years before publishing *Seeing Like a State*: "The postrevolutionary Mexican state, though surely a child of the Enlightenment and of nineteenth-century views of scientific progress, was far less determined, it seems, than was Lenin to force a high-modernist, centralized, utopian grid on society at no matter what cost."¹⁶ Similarly, Mitchell employs the term "technopolitics" to describe the relationship between expertise and development worldwide during the twentieth century. With it he means to describe how political and economic demands within a liberal capitalist and colonial order affected supposedly objective, impartial experts, such as engineers and social scientists. Such demands impelled them to presume not only that nature and peasant agriculture were inherently defective but that the wider society and economy were, too. Yet in applying technopolitics to Egypt, Mitchell includes an important caveat: although experts portrayed nature and society as passive and needing improvement, or as forces merely to be acted on, a concrete understanding of the relationship of science to development came into being only by *working with* natural and social forces.¹⁷

In recent years, historians of Latin America have highlighted the "middling" roles *técnicos* played between state and society, much like the roles that teachers and artists played in the cultural sphere.¹⁸ Mark Carey, in particular, describes

government-employed glacier experts in Peru as generally “mediating” between various competing social groups as well as the physical environment.¹⁹ As Bruno Latour makes clear, mediators and intermediaries are not interchangeable: intermediaries convey meaning or force without modification, whereas mediators “transform, translate, distort, and modify the meaning or the elements they are supposed to” convey.²⁰ Intermediaries, like conduits, merely transmit messages between social groups while mediators both translate and complicate those same messages by introducing their own agendas. In this book, unlike Scott’s and Mitchell’s portrayals in other countries, Mexican *técnicos*-cum-government employees were decidedly mediators and not mere intermediaries, for they actively shaped and transformed a developmental agenda ostensibly imposed by the state. They did so not only from their offices in Mexico City, but, as was the case in the Laguna, also as troubleshooters sent out by the government to resolve local land and water issues. There, they mediated, in this Latourian sense, envirotechnical knowledge between the soft authoritarian Mexican state and a deeply divided but very active and far from prostrate civil society.

As a group, Mexican *técnicos* exhibited a puzzling combination of traits: the mundane and the imperfect, yet also the ambitious and the fair-minded. They certainly had their limitations, for as informal mediators of envirotechnical knowledge, *técnicos* were partial to the state not only for the understandable reason that they were, at the end of the day, state employees seeking promotion or just to keep their jobs. Several of them with high-level political appointments went further and took advantage of business opportunities that their privileged positions opened up, creating conflicts of interest. Yet whether they were high-, mid-, or low-level government *técnicos*, their professional ethos nevertheless required, in the historian Richard White’s phrase, “getting to know nature through labor.”²¹ By labor, White meant hard, manual labor, such as fishing or canoeing, on the Columbia River. Two Lagunero muralists in the 1940s similarly depicted such a relationship between labor and the Nazas, but they differed starkly according to their class ideologies. Figure Intro.5, for instance, is an *agrarista* depiction of bare-chested mestizo men doing the hard, physical labor of maintaining irrigation canals while a mestiza woman sits at their side with a vessel of water. They look out reverently at the cresting Nazas within a desolate landscape. By contrast, figure Intro.6 is a landowner’s depiction of nicely dressed, and light-skinned, men and women joyously harvesting cotton and fruit while the Nazas flows through a bountiful landscape.

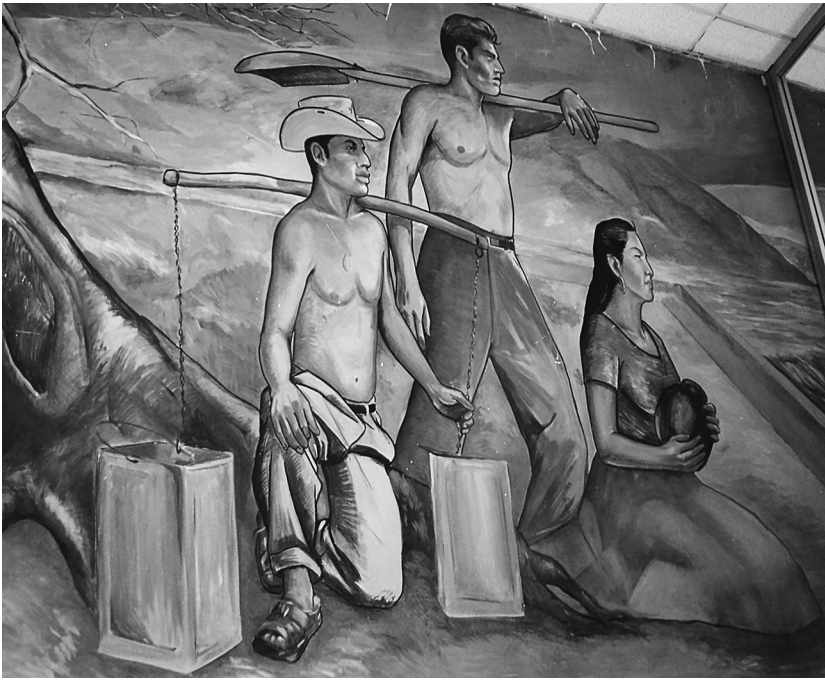


FIG. INTRO.5 An agrarista depiction of agricultural workers revering the cresting Nazas. Author's photograph of public mural painted in the 1940s in Torreón, Coahuila, Mexico, 2006.

Whereas workers and campesinos got to know nature through their physical labor, *técnicos* did so through the *envirotechnical* labor of reconnoitering, measuring, and modeling natural processes (hydrological cycles, soil quality, climate, and so forth) for fairer water distribution before the Revolution and, in its wake, fairer land and water distribution. Yet even while they did so wholeheartedly, some *técnicos* rapidly discovered and openly admitted the large discrepancy between the hubristic attitude their formal education had instilled in them toward nature and the reality of its finite and fragile boundaries. Thus *técnicos* primarily concerned with spurring development in Mexico—arguably the vast majority—occasionally became what I term “incidental conservationists.” That is, they came to realize conservation was not a luxury that could wait until Mexico achieved “developed” status, as Mexican and other “developing” nation politicians insisted (and often continue to). Instead, they saw conservation as an urgent necessity to ensure the long-term viability of key developmental objectives such as agrarian reform.²²



FIG. INTRO.6 A landowner's depiction of nicely dressed, and light-skinned, men and women joyously harvesting cotton and fruit while the Nazas flows through a bountiful landscape. Author's photograph of public mural painted in the 1940s in Torreón, Coahuila, Mexico, 2006.

Incidentally Conserving El Agua de la Revolución

Generally, Mexican *técnicos*' incidental conservationism was primarily utilitarian, similar to the U.S. Progressive "wise use" of natural resources, but it could vary, both individually from one *técnico* to another and according to the resource (surface water, groundwater, forests, minerals, soil), its location, and how it was extracted and exploited.²³ Conservation of forests, for instance, as Christopher Boyer and Emily Wakild's recent environmental histories of Mexico have shown, morphed from utilitarian conservationism before the Revolution into a more deliberate policy of "social and political landscaping" after the Revolution, a policy exemplified by the forty national parks that Cárdenas founded in the 1930s. Government foresters, some of whom had trained as civil engineers, sought to accomplish the revolutionary goal of more equitable distribution of natural resources through joint state-community management of forests that would balance preservation of their biological integrity and sustainable use of their resources.²⁴

Yet unlike old or second growth forest conservation (as distinct from tree plantations), which was a response to overcutting with increasingly powerful

technologies, water conservation initially played handmaiden to the advent of modern and invasive hydraulic technology. As Donald Worster explains in his classic *Rivers of Empire*, in early eighteenth-century England, before the Industrial Revolution and the age of technological dominance that it ushered in globally, conserving a river had long meant letting it flow and the fish it supported, swim free. But by the late nineteenth century and early twentieth century, conservation “had nothing to do with protecting rivers from harm, with preserving their integrity, or with saving them for posterity’s enjoyment.” Instead, it signified the opposite: conserving water meant damming rivers and creating “reservoirs,” or large artificial lakes, for human water supply, flood control, power, and even recreation. This newer understanding of “conservation” sought to prevent “wasting” water, even at the cost of dramatically altering the integrity of natural hydrological cycles.²⁵

The Mexican technical elite in the late nineteenth century embraced these principles and helped set national water policy on a historical trajectory distinct from forest conservation.²⁶ The case of the French-educated civil engineer Miguel Ángel de Quevedo is instructive in this regard. Nicknamed the “apostle of the tree” during his long career from the late nineteenth century to the 1940s, he lobbied successive presidents to adopt a policy of “ecological paternalism.” In his view, the state had a moral obligation to protect forests from the depredations of campesinos by replacing—as he saw it—their antiquated, unsustainable agricultural practices with more modern, profitable, and sustainable ones.²⁷

One of Quevedo’s major achievements toward this end was successfully lobbying for a conservationist provision in the revolutionary Constitution of 1917. In his memoir, he describes how his many years of advocating for conservation legislation began with his “alarm” at Mexico’s rampant deforestation while he worked on a hydroelectric plant as a young engineer. The plant could not perform at capacity because of a low water level that he attributed to clear-cutting in the nearby hills, and when he researched what laws existed to stop such reckless deforestation, he discovered none in the Constitution of 1857. He then mistakenly assumed that the government could only apply the colonial Law of the Indies and a few inefficient and ineffective state and local government laws. Through his personal connection to future President Venustiano Carranza’s secretary of agriculture, the engineer Pastor Rouaix, he created an opportune historical moment during the Revolution, inviting Carranza and the secretary of the Constitutional Congress of 1917 to his home in Mexico City.²⁸

While he hosted these two powerful revolutionaries, Quevedo impressed on them the need to remedy Mexico’s deficient conservation laws by inserting a provision in the new Constitution for “Conservation of National Biological

Resources of Flora and Fauna” modeled on resolutions approved by the North American Natural Resource Conservation Convention, held in Washington, DC, in 1909. Representing Theodore Roosevelt, Gifford Pinchot, the chief U.S. forester, invited Mexico to the convention, which Quevedo and the agricultural engineer Rómulo Escobar attended as representatives. Yet the Mexican government under Díaz, who favorably received Quevedo and Escobar’s report when they returned from the convention, was unable to match the conservation efforts of the United States and Canada, for Quevedo believed it lacked legal authority to pass a federal conservation law under the 1857 Constitution. The promulgation of the new 1917 Constitution—with its incorporation of the conservationist provision in Article 27—explicitly enabled congressional passage of a comprehensive forestry code in 1926.²⁹ As a result, Mexico’s new Constitution surpassed that of the United States as the first charter in the world to combine social and environmental rights.³⁰

Although Quevedo successfully persuaded revolutionaries to incorporate the provision in the new constitution, the language they used for Article 27 was contradictory and vague. On the one hand, the article affirmed the collective right of the Mexican populace to use and exploit water, woods, and pasturelands and to develop agriculture on state-granted or redistributed lands. On the other hand, it also obligated the “Nation” (the citizens of Mexico represented by their state) to conserve, and prevent the destruction of, those same natural resources in the public interest. It did not specify how the government would simultaneously satisfy the popular demand for agricultural development and enforce the right of the nation to impose conservation of natural resources. Even more elementally, it failed to stipulate precisely what the nation’s relationship to its natural resources was.

In particular, the wording that a certain resource “originally belongs [*corresponde originariamente*] to the Nation” and is “the property of the Nation,” suggested that the article’s goal was complete nationalization of natural resources. But in the very same clause it also clearly upheld private ownership of natural resources except when the state determined they were of “public utility.”³¹ This vagueness and contradictoriness reflected several factors, including the eclectic property regimes that independent Mexico inherited in 1821; the violent fractiousness of the Revolution; and Quevedo’s conception of conservation as a combination of preserving natural resources for biological, aesthetic, and health reasons and Pinchot-inspired wise use of them for long-term economic development.³²

Revolutionaries’ approach to water resources, however, was more confusing than vague, as Article 27’s authors included surface water and not groundwater,

which they defined as “water extracted from mines.”³³ The historian Luis Aboites used “El agua de la nación” (the water of the nation), also the title of his influential 1998 book, *El agua de la nación*, to conceptually denote the process by which an inexorably “centralizing/federalizing” Mexican state defined water as national property from 1888 to 1946. He chose 1888 to start this periodization because Díaz pushed a law through Congress that year placing most navigable rivers under federal jurisdiction to grant water from the (actually non-navigable) Nazas River to the Laguna-based Tlahualilo Cotton Company. The end of his periodization, 1946, was a watershed event: the Mexican government replaced the subministerial CNI with the Secretaría de Recursos Hidráulicos (Ministry of Hydraulic Resources) and in so doing created the only ministry of its kind in the Western Hemisphere. The replacement symbolized both the importance of hydraulic resource development to the postrevolutionary Mexican state and the increasing power the state had amassed over water management throughout the country. Indeed, the CNI, founded by President Plutarco Elías Calles in 1926, for twenty years had been charged with spurring formation of a prosperous class of Mexican farmers, whether small individual landholders as envisioned by Calles or ejidos by Cárdenas, through irrigation and colonization schemes.³⁴ These historical developments reflected Aboites’s thesis of inexorable centralization/federalization of water in Mexico and the “social uses” of water that it subsumed in an array of contexts and regions. He defined social uses of water as “the concrete forms which human labor oriented toward controlling, storing and distributing water, as well as its diverse forms of appropriation and regulation, assumes.”³⁵ Although each historical period (Porfiriato, Revolution, postrevolutionary reconstruction) would have its defining features, Aboites’s goal was to make federal appropriation of water resources an essential and enduring component of Mexican political history during the late nineteenth century and twentieth century.

Toward that end, Aboites and several other historians drew on the rich repository of the Archivo Histórico del Agua (Historical Water Archive; AHA) to pioneer water history in Mexico, long a subfield of agrarian history.³⁶ Established in Mexico City in 1994, this unique archive has made tens of thousands of documents—correspondence of engineers, water user concessions, petitions and complaints, reports, analyses, contracts, maps, diagrams, photos, and other sources—from government water agencies at all levels easily accessible to researchers. Since the publication of *El agua de la nación*, water historians of Mexico have produced many detailed historical case studies focused on specific cities, regions, states, and river basins of Mexico. These studies elucidate the complex relationship between land and water policies, the changing tech-

nologies of water use, and the often confusing and overlapping jurisdictions—municipal, state, and federal—for managing the social uses of water. This continuously growing literature, including Aboites's sequel *La decadencia del agua de la nación* (The Decadence of the Water of the Nation), has revised *El agua de la nación*'s overarching framework, demonstrating that the federalization of water resources was less inexorable, top-down, and far-reaching than Aboites first argued.³⁷

Aboites's initial work and the revisions it inspired made crucial and innovative contributions to Mexican history but are insufficient. For this book, I searched the AHA along with numerous national, state, regional, local, and U.S. archives from an envirotechnical perspective (seeing environmental and technological processes as intertwined and overlapping) and concluded that there is a need for a new and more precise paradigm: the term "El agua de la nación" should be replaced with what I call "El agua de la Revolución" (the water of the Revolution). El agua de la Revolución reflects the reality that water, in Mexican history, was not just an abstract resource over which the state claimed jurisdiction for economic development and growth but also a tangible necessity the state would have to actively manage and supervise—indeed, engineer—as *a matter of social justice*.

Specifically, the old paradigm of El agua de la nación encapsulates the process of the federalization of water in Mexico beginning with the Ley sobre aprovechamientos de aguas de jurisdicción federal (Law on the Use of Waters under Federal Jurisdiction), passed in December 1910 under Díaz, and for good reason: the 1910 law expanded federal jurisdiction over far more waterways than the 1888 water law by stating that *all* rivers were of the "public dominion and common use, and in consequence, inalienable and imprescriptible."³⁸ In *El agua de la nación*'s linear narrative, the 1910 water law set the stage, seven years later, for Article 27 to build on the continuous progress that Mexico had made in water matters since 1888. Indeed, both the 1910 water law and Article 27 empowered the state to distribute water as a public good at its discretion. Yet Article 27 went further by defining water as unequivocally belonging to the Mexican people and not merely to an ownerless public dominion managed by the state, per the 1910 water law. Key to this new definition in Article 27 was also making popular *access* to water into a social right. As a resource scarcer than land, water in Mexico was equally valuable and generated powerful interests invested in it. By stipulating that all citizens have access to land *and* water, Article 27 mandated, in practical terms, redistribution of wealth to the poor agrarian majority, whereas the 1910 law, as progressive as it was for its time, did not explicitly mandate redistribution. Instead, it only allowed the federal government to

grant use of water under its jurisdiction to “private individuals, companies constituted according to national laws, and Mexican private or public corporations which have the legal capacity to obtain such concessions.”³⁹ In contrast, Article 27 empowered the nation with the “right to impose on private property the modalities that the public interest dictates . . . *in order to equitably distribute public wealth as well as to conserve it.*”⁴⁰ The difference between the wording of the two regarding distribution of resources, with one not mentioning it at all and the other making it central, could not be more evident.

Therefore, the term “El agua de la Revolución” in this book describes two distinct, but interrelated, historical processes that converged juridically, socially, and politically shortly before and during the Mexican Revolution: the authority of the Mexican state to regulate water within its widening jurisdiction per the 1910 water law *and* the mandate to redistribute and conserve it per Article 27 of the 1917 Constitution. After all, it was only thanks to the Revolution that the conservative upper-middle-class landowner Carranza’s victorious faction could constitutionally define water as the “property of the Nation” that could legally be, but was never—not even at the height of Mexican authoritarian state power in the 1950s–70s—completely federalized. Although Carrancistas defeated their more radical Zapatista archrivals on the battlefield, Carrancista constitutional delegates largely incorporated Zapata’s 1911 Plan of Ayala demanding large-scale agrarian reform. In 1917, they understood that Zapatismo and allied Villismo had transformed the Revolution into a true social and not merely political revolution.⁴¹ To reflect the fact that the Revolution was a social revolution, in this book I use the more precise paradigm of El agua de la Revolución to refer to Mexico’s postrevolutionary water resources, especially the Nazas River. The “Nazas question,” as it was called from the late nineteenth century to the 1930s, had the largest influence on Mexican federal water law during this critical period.⁴²

It is difficult to ascertain how aware Mexican técnicos were of Article 27’s conservationist provision, and, if they were aware, how they thought it was applicable to water conservation.⁴³ For his part, Quevedo felt that his fellow civil, agricultural, and hydraulic engineers did not sufficiently appreciate the connection among intact forests, water supply regeneration, and soil quality—or what is known today as “desiccation theory.”⁴⁴ He thus made numerous efforts during his long career to educate them on the important role that forests played in the hydrological cycle, as he understood it. Despite advocating this more holistic approach to engineering, Quevedo persisted with the work he began early in his career, during Díaz’s presidency, of continuing the *desagüe* (the centuries-long project of draining Mexico City’s lakes), an indicator that

he had no qualms about grand hydraulic infrastructure building—provided it was economically feasible, technically sound, and truly necessary. He believed that the criterion of necessity should be assessed case by case, including the case of the Nazas River Dam. Notably, after closely examining it, he concluded the dam was unnecessary.

More far-sighted than his peers on many fronts, Quevedo also linked forest conservation to a healthy groundwater supply, arguing that reforested hillsides attracted more precipitation, retained more water, and was therefore a cost-effective way to recharge aquifers. Yet conserving surface water and conserving groundwater were different beasts. Whereas conserving surface water primarily meant damming and creating reservoirs that made great rivers such as the Colorado into “a river no more,”⁴⁵ conserving groundwater—especially as farmers installed more and more motorized pumps running on fuel or electricity in the 1920s and 1930s—increasingly entailed regulating pumping and preserving the natural integrity of aquifers. Unlike deforestation, however, which is visible to the eye and quantifiable (though before the advent of satellites, not always easily), accurately measuring groundwater volume was nearly impossible before the late twentieth century. When the government finally decided to do it, its measurements were a matter of educated guesswork. Not until the 1940s and 1950s, two decades after motorized groundwater pumping had commenced on a large scale in Mexico, did federal engineers estimate a total national groundwater supply, and even then their estimates ranged widely: from 180,000 to 350,000 cubic megameters, depending on the different methods they employed.⁴⁶ But to any farmer who had to drill deeper and deeper for water that was progressively contaminated with salt and toxic substances such as arsenic, it was obvious, even in the absence of a reliable measurement of total volume, when an aquifer was overexploited.

In the history of conservation in Mexico—as well as globally—there are sharp distinctions in how people deployed technology that must be highlighted, for, as this book shows, the distinctions become more consequential over time: clear differences between conserving forests and water, as well as subtler, but no less important, differences between conserving surface and subsurface water. When *técnicos* and others advocated conserving water by regulating rivers via dams, they imagined technology dominating an unruly nature, transforming the latter into a productive force for humanity. By contrast, when they called for conserving groundwater, it was in response to humanity’s excessive technological invasion of finite and fragile aquifers. *Técnicos* wanted the conservation of surface and groundwater to be two distinct tasks, requiring two different technologies, but nature—no matter how much technology modified it—made no

distinction; surface and subsurface water could not be conserved separately in the Laguna. The irony was that Laguneros who employed a much simpler human technology implicitly recognized this and had already created a sustainable—albeit erratic—irrigation system. For generations through *aniego*, they diverted the Nazas floodwaters into an extensive earthen canal network that was an important source for recharging overexploited aquifers. While a dam reservoir would conserve water, it could also impede aquifer recharge by reducing the free flow on which *aniego* depended.

Mexican *técnicos* who understood the delicate and interconnected hydrological cycle between surface water and groundwater did not miss the irony that by building a dam on the Nazas to “conserve” water, they would be damaging an equally important source of water: the aquifer. And this damage would disproportionately affect *ejidatarios*, the intended beneficiaries of Cardenista agrarian reform. On balance, however, most *técnicos*, according to the massive documentation they left behind, were convinced that the perceived economic and political benefits of dam building far outweighed its predictable social and environmental costs. Whatever envirotechnical problems they expected deployment of their hydraulic technology to create, they had unbridled faith that more advanced technology could solve them later. By and large, they would remain, far past the point any responsible scientist should have been even before the rise of environmentalism beginning in the 1970s, negligent, at best, and callous, at worst, about how invasive deployment of their technology would prove to be. In this respect, they were no different from their counterparts throughout the world.

INTRODUCTION

Epigraphs: Cosío Villegas, “La crisis de México,” 39; Rulfo, *The Burning Plain and Other Stories*, 11–12.

1. Kourí, “Claroscuros de la reforma agraria mexicana,” *Nexos en línea*, <http://www.nexos.com.mx/?p=14062>, accessed February 22, 2016.

2. For a detailed history of the company and its operations, see Cerutti and Rivas Sada, “El Grupo Industrial LALA.”

3. Brunk, *Emiliano Zapata*, 43–44.

4. Clipping of Marshall Hail, “Cárdenas Hailed by Crowds as Messiah for Land Reforms,” *Washington Times*, November 21, 1936, Archivo General de la Nación (AGN), Ramo Presidenciales (RP), Lázaro Cárdenas (LC), 404.1/706, 922.

5. Enrique Vázquez Ávila, Laguna farmer and engineer, interview by the author, Torreón, Coahuila, April 25, 2006.

6. As the general map at the front of this book shows, the Aguanaval River also waters the Laguna; hence, the region is located in the Nazas-Aguanaval river basin (see map FM.1). The flow of the Aguanaval River, however, is a fraction of that of the Nazas and will thus be mentioned only occasionally throughout this book. For a map of Mexico’s thirty-seven river basins, see Comisión Nacional del Agua, *Estadísticas del agua en México*, 19.

7. I define environmental history as the study of the relationship between people—their society, culture, and politics—and the environment, broadly defined, over time, and the history of technology as the study of how people have made and done things using different kinds of techniques, objects, and materials that interact with society, culture, politics and the environment over time.

8. Reuss and Cutcliffe, eds., *The Illusory Boundary*, vii, 1; Jørgensen, Jørgensen, and Pritchard, eds., *New Natures*.

9. Mitchell, *Rule of Experts*, 34–35. For an explicitly envirotech history of the Rhône during the late twentieth century, see Pritchard, *Confluence*.

10. Medina, da Costa Marques, and Holmes, eds., *Beyond Imported Magic*.

11. Latin American environmental historiography is now large and growing rapidly. For an overview, see Carey, “Commodities, Colonial Science, and Environmental Change in Latin

American History.” For environmental histories of water in Mexico, see Tortolero, ed., *Tierra, agua y bosques*; Loreto López, ed., *Agua, poder urbano y metabolismo social*; Evans, “Water and Environmental Change in the U.S.-Mexico Borderlands”; and Boyer, ed., *A Land between Waters*, among others. Boyer’s volume includes chapters on various natural resources published by Mexican and U.S. environmental historians together for the first time. Likewise, the historiography of technology in Latin America is large and growing. For an overview, see Beatty, Pineda, and Sáiz, “Technology in Latin America’s Past and Present.” For book-length studies, see, among many others, Beatty, *Technology and the Search for Progress in Modern Mexico*; Domínguez Martínez, *La ingeniería civil en México*; and Medina, da Costa Marques, and Holmes et al., *Beyond Imported Magic*; Safford, *The Ideal of the Practical*. Medina and colleagues’ volume is also part of the large literature on history of science in Latin America that often overlaps with the history of technology but less regularly with that of environmental history. For overviews of history of science in Latin America, see Glick, “Science and Independence in Latin America”; Saldaña, *Science in Latin America*; and Fishburn and Ortiz, eds., *Science and the Creative Imagination in Latin America*. For a notable exception that integrates environmental history with the history of science and technology in colonial Mexico City, see Candiani, *Dreaming of Dry Land*.

12. There is no comprehensive study of engineers and engineering throughout Mexican history, but there are several useful studies of engineering education and particular kinds of engineers and engineering during specific periods: Candiani, *Dreaming of Dry Land*, 171–75; Ramos Lara and Sánchez Estrada, “Antecedentes históricos del Colegio de Ingenieros”; Ervin, “The Art of the Possible”; Lucena, “De Criollos a Mexicanos”; Gortari Rabiela, “Educación y conciencia nacional”; Ayala, Herrera, and Pons, ed., *Ingenieros en la Independencia y la Revolución*; Chávez, *Ingeniería y humanismo*; Moles Batllell, *La enseñanza de la ingeniería mexicana, 1792–1990*; Domínguez Martínez, *La ingeniería civil en México, 1900–1940*.

13. Jiménez, “La contribución de la Comisión Nacional de Irrigación en adelante de la ingeniería en México.”

14. Smith and Marx, eds., *Does Technology Drive History?*, xii.

15. Scott, *Seeing Like a State*. See also Josephson, *Industrialized Nature* and Josephson, *Resources under Regimes*. For examinations of China, Cuba, and Germany that implicitly and explicitly adopt Scott’s model of high modernity, see, respectively, Shapiro, *Mao’s War against Nature*; Díaz-Briquets and Pérez-López, *Conquering Nature*; and Blackbourn, *The Conquest of Nature*. For a trenchant critique of Scott, see Coronil, “Smelling Like a Market.” For more nuanced critiques, see, respectively, Jess Gilbert, “Low Modernism and the Agrarian New Deal”; Mathews, *Instituting Nature*.

16. Joseph and Nugent, eds., *Everyday Forms of State Formation*, x.

17. Mitchell, *Rule of Experts*, 15, 51; the italics are mine. Mitchell differentiates himself from Scott in this way by focusing on the social and political practices that simultaneously produce the powers of modern states and science—as opposed to (primarily authoritarian socialist) states’ abusing science and imposing it on civil societies unable to resist. While I embrace this difference, I would also add that the powers of any state (liberal democratic, state capitalist, rightist, and fascist, as well as socialist) and science are not only mutually constitutive; they also synergistically produce knowledge and awareness of natural

resource scarcity and the corresponding need for conservation, a point on which I elaborate later. For additional definitions of technopolitics complementary to, but slightly modified from, Mitchell, see Hecht, *Entangled Geographies: Empire and Technopolitics in the Global Cold War*, 3.

18. On plant scientists in the Caribbean, see McCook, *States of Nature*. On Mexican agronomists, see Ervin, “The 1930 Agrarian Census in Mexico.” On urban environmental planners and engineers working on the desagüe of Mexico City, see Vitz, “‘The Lands with Which We Shall Struggle’” and Candiani, *Dreaming of Dry Land*. On Mexican and Chilean foresters, see, respectively, Boyer, *Political Landscapes* and Klubock, *La Frontera*.

19. Carey, *In the Shadow of Melting Glaciers*, 6. On the similar role that “political engineering” played in Francoist Spain, see Camprubí, *Engineers and the Making of the Francoist Regime*. On the role that the “technological imaginary” or “imagineering” played in wartime Japan, see Moore, *Constructing East Asia*.

20. Latour, *Reassembling the Social*, 39.

21. White, *The Organic Machine*.

22. I do not hereby suggest that developed countries have solved their environmental problems or that their politicians do not make the same arguments about the burdensome economic “cost” of environmental protection (without, of course, accounting for the far costlier “externalities” of development). The difference is that having already achieved “developed” status, they speak not of catching up developmentally but instead of maintaining global competitiveness. For a critical global history of development, see Rist, *The History of Development*.

23. Gifford Pinchot popularized the concept of wise use as one that made no distinction between development and the conservation of natural resources. As he wrote, “The first principle of conservation is development, the use of the natural resources now existing on this continent for the benefit of the people who live here now.” Statements such as these, taken out of context, inspired the conservative anti-environmentalist (virtually synonymous with anti-regulatory) wise-use movement in the western United States in the late 1980s and 1990s, recently revived in the mid-2010s. Pinchot made it clear that he envisioned a strong federal role in conservation to prevent unnecessary “waste” of resources. This included a redistributive regulatory agenda of preserving natural resources “for the benefit of the many, and not merely for the profit of a few.” Pinchot, *The Fight for Conservation*, chap. 4. For how this conception of wise use in Mexico applied to conservation of oil resources in Mexico, see Santiago, *The Ecology of Oil*.

24. Boyer and Wakild, “Social Landscaping in the Forests of Mexico.” See also Wakild, *Revolutionary Parks: Conservation, Social Justice, and Mexico’s National Parks, 1910–1940*; Boyer, *Political Landscapes*.

25. Worster, *Rivers of Empire*, 154–55. For Mexican perspectives and attitudes on water control in the late nineteenth century and early twentieth century, see Gayol, *Dos problemas de vital importancia para México*, Herrera y Lasso, *Apuntes sobre irrigación*, and Molina Enríquez, *Los grandes problemas nacionales*. For Worsterian but revisionist studies of European and North American rivers, see Mauch and Zeller, eds., *Rivers in History*. Peter Perdue points out a similar change in Chinese attitudes toward free-flowing rivers between Confucianists and Daoists. The former advocated water conservancy by controlling river flow whereas the

latter advised letting water flow freely and resettling people accordingly. Perdue, “A Chinese View of Technology and Nature?,” 107.

26. It should be noted that in the United States there was a difference between “conservationists” and “preservationists” that was not as marked in Mexico. U.S. conservationists believed a balance between the utilization and the protection of natural resources could be struck while preservationists felt forests should remain basically intact. Worster, *Nature’s Economy*, 258–90. The U.S. preservationist John Muir also opposed large dam projects to preserve river basins on aesthetic grounds, such as the Hetch Hetchy in Yosemite, a bitter battle which he lost.

27. Boyer, “Revolución y paternalismo ecológico.” Like in Europe, however, applying scientific forestry for “maximum sustained yield” logging, which also included creating monocrop tree plantations in place of old-growth forests, could be considered “conservation” in Mexico: Boyer, *Political Landscapes*, 8. For Chilean foresters, too, conservation from the late nineteenth century came to signify replacing old- and second-growth forest, or lands deforested of them, with tree plantations, especially in the south. They generally advocated conserving old and second-growth forest primarily within national parks and preserves that—unlike Mexico in this case—excluded campesinos and indigenous communities: Thomas Klubock, *La Frontera: Forests and Ecological Conflict in Chile’s Frontier Territory*. Neither Boyer nor Klubock, however, explicitly explore the role that technology played in fostering changing notions of forest conservation in Mexico and Chile, respectively.

28. De Quevedo, *Relato de mi vida*, 39–40. The government of Benito Juárez had in fact established a federal forestry statute in 1861, decades before the United States did in 1894. Simonian, *Defending the Land of the Jaguar*, 54.

29. De Quevedo, *Relato de mi vida*, 39–40.

30. In his survey of Latin American liberalism and its role in promoting social rights globally, the historian Greg Grandin described Mexico’s 1917 Constitution as the “world’s first fully conceived social-democratic charter, enshrining the right to organize unions, the right to work, a minimum wage, equal pay for men and women, welfare, education, and healthcare.” Grandin, “The Liberal Traditions in the Americas,” 74–75. But the Constitution’s key social right was agrarian reform in a predominantly rural country where the majority lacked land and therefore an opportunity for a decent livelihood. My use of “environmental” is admittedly anachronistic in a pre-environmentalist (pre-1980s) historical context. To be sure, the terms *ambiente* and *medio-ambiente* for the natural environment were not in common use in Mexico before the 1970s, as attested by keyword searches in Mexican digital newspaper archives covering the years 1910–70. By using the English word, I am referring to rights to *access* and *use* natural resources, not to protect or venerate them as if they had intrinsic value. People at the time may or may not have felt they had intrinsic value, depending on their particular sociocultural experiences with, and attitudes toward, nonhuman nature.

31. For excerpts translated into English, see Joseph and Henderson, eds., *The Mexico Reader*, 400. For the full text of Article 27 in the original Spanish, see <http://www.juridicas.unam.mx/infjur/leg/consthist/pdf/1917.pdf>, 13–14, accessed February 22, 2016.

32. For discussion of early water law in the context of property after independence, see Núñez Luna, “Water Law and the Making of the Mexican State, 1875–1917,” PhD diss., Har-

vard University, Cambridge, MA, 2011, 45–52. Although Article 27's objective was *not* sustainable resource management of the kind advocated from the late twentieth century, it nevertheless “established a juridical framework that is notably similar to the thesis of the new environmental philosophy of the past decades,” according to the Mexican ecologist Víctor Toledo in the 1990s. Toledo, “The Ecological Consequences of the 1992 Agrarian Law of Mexico,” 254.

33. It would take nearly thirty years for groundwater to be placed under federal jurisdiction and nearly fifty years before it was unequivocally defined as national property. For details, see chap. 5 in this volume.

34. Aboites, *El agua de la nación*, 107–12.

35. Aboites, *El agua de la nación*, 16. In many ways, the work was a synthetic successor to his previous case study, *La irrigación revolucionaria*, discussed in chap. 2 and Kroeber's *Man, Land, and Water*, a tome surveying various water projects throughout Mexico and their intellectual and policy genealogies during the late Porfiriato. Kroeber showed that by the time of the Revolution, an incipient national irrigation policy was in formation on which revolutionary leaders would greatly expand.

36. The agrarian historiography of Mexico, especially on agrarian reform since the Revolution, is enormous. A few prominent examples include Simpson, *The Ejido*; Silva Herzog, ed., *El agrarismo mexicano y la reforma agraria*; Eckstein, *El ejido colectivo en México*; Hamilton, *The Limits of State Autonomy*; Sanderson, *Land Reform in Mexico, 1910–1980*; *Historia de la cuestión agraria mexicana* (9 volumes); Gledhill, *Casi Nada*; Randall, ed., *Reforming Mexico's Agrarian Reform*; Fallaw, *Cárdenas Compromised*; Morett Sánchez, *Reforma Agraria*; and Dwyer, *The Agrarian Dispute*. For selected works on the Laguna, which has generated an impressive subfield of “Lagunology” due to its emblematic agrarian reform, see, among others: Senior, *Democracy Comes to a Cotton Kingdom*; Mendizábal, “El problema agrario de la Laguna”; Restrepo and Eckstein, *La agricultura colectiva en México*; Carr, “The Mexican Communist Party and Agrarian Mobilization in the Laguna, 1920–1940”; Olcott, *Revolutionary Women in Postrevolutionary Mexico*, chap. 4; and Rivas Sada, “Cambio tecnológico, dinámica regional y reconversión productiva en el norte de México. La Comarca Lagunera, 1925–1974.”

37. In addition to many dozens of articles published regularly in the quarterly *Boletín del Archivo Histórico del Agua* since 1994, these include, among many others, Castañeda González, *Irrigación y reforma agraria*, Suárez Cortez and Gardida, *Dos estudios sobre usos del agua en México (siglos XIX y XX)*, Suárez Cortez, *Historia de los usos del agua en México*, Aboites, ed., *Fuentes para la historia de los usos del agua en México (1710–1951)*, Aboites, *Demografía histórica y conflictos por el agua*, Aboites and Estrada, eds., *Del agua municipal al agua nacional*, Camacho Altamirano, *Empresarios e ingenieros en la ciudad de San Luis Potosí*, Escobar Ohmstede and Rojas Rabiela, eds., *Estructuras y formas agrarias en México*, Durán, Sánchez, and Escobar Ohmstede, eds., *El agua en la historia de México*, Escobar, Sánchez, and Gutiérrez, eds., *Agua y tierra en México, siglos XIX y XX*, and Escobar and Butler, eds., *Mexico in Transition*. The last four edited volumes have advanced the field considerably through their diversity, breadth, and depth of case studies and are prompting broad revision of fundamental tenets of Mexican agrarian history, particularly land disentanglement (or privatization) before the Revolution; agrarian reform after it; and the transformation in natural resource

use, management, and jurisdiction surrounding them, with an emphasis on water as integral to land.

38. Aboites, *El agua de la nación*, 92.

39. Lanz Cárdenas, *Legislación de aguas en México*, 425–27.

40. Joseph and Henderson, *The Mexico Reader*, 398–99; italics added.

41. There is much debate in the historiography of the Mexican Revolution as to what kind of revolution it was, and how popular it was, on a continuum from elite-led and mass-manipulated at one end to radically democratic and participatory at the other. Wherever along the definitional continuum one pinpoints the Revolution, one thing is clear: agrarian reform was the central revolutionary demand in an agrarian country beset with highly unequal land distribution. It is in this sense that I subscribe to Alan Knight's view that the Mexican Revolution was "a popular, agrarian movement—the precursor, the necessary precursor, of the *étatiste* 'revolution' of post-1920." Knight, *The Mexican Revolution*, vol. 1, xi.

42. There is a large body of literature on the Nazas question, primarily for the Porfiriato: see Núñez Luna, "Water Law and the Making of the Mexican State"; Meyers, *Forge of Progress, Crucible of Revolt*; Plana, *El reino del algodón en México*; Kroeber, "La cuestión del Nazas hasta 1913"; Villa Guerrero, "Una mina de oro blanco." For a study incorporating this discussion that goes beyond the Porfiriato through the twentieth century, see Wolfe, "El Agua de la Revolución."

43. Not one técnico I quote in this book directly referenced the conservationist provision of Article 27, though he (all were men) was concerned with conserving water.

44. Mathews, *Instituting Nature*, 40, points out that environmental scientists currently believe the theory "is only partially correct."

45. Fradkin, *A River No More*.

46. Moreno Vázquez, *Por abajo del agua*, 55.

CHAPTER 1. RIVER OF REVOLUTION

Epigraph: Othón, *Obras de Manuel José Othón*, vol. 1, 238. I am grateful to Ana Minian and Lisa Surwillo for their assistance in translating this poem.

1. Madero, *Estudio sobre la conveniencia de la construcción de una presa*, 53–55.

2. Madero, *Estudio sobre la conveniencia de la construcción de una presa*, 27.

3. As early as 1895, after reconnoitering the Nazas and Aguanaval rivers, commission engineers and a geologist from the National Geological Institute concluded that "it was apparent there would be silting problems and possible detriment to fertilizing lands." They anticipated the arguments against the project that Madero would try to counter by referencing subsequent studies, about which more below. See "Remitiendo informe general de los trabajos relativos a la presa el cañón de Fernández," 1904 (AHA), Aguas Superficiales (AS), box 4350, file 577731; Riemann, *Memoria del Distrito de Riego de la Región Lagunera, Coahuila y Durango*, 7.

4. In the colonial documentation, the now so-called Comarca Lagunera refers more to a "region in which there are lakes" than a "region where there is a lake," the latter lake denoting the "Laguna de Mayrán": Corona Páez, *El País de La Laguna*, 21n2.

5. Irritilla, *400 años de historia del Río Nazas*, 6. Of the twelve rivers (Fuerte, Sinaloa, Morcorito, Pericos, Culiacán, San Lorenzo, Elota, Piaxtla, Quelite, Presidio, Baluarte, Nazas) that