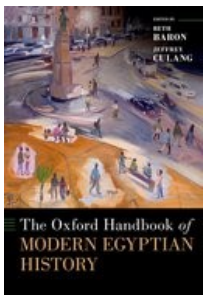

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CHAPTER

10 Dams, Ditches, and Drains: Managing Egypt's Modern Hydroscape

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Abstract

Egypt was integrated as a unified water landscape, or hydroscape, during the nineteenth and twentieth centuries through the accumulated efforts of engineers, farmers, and state officials who constructed ever-larger water management projects to channel Nile water. While these efforts initially increased centralized control of water, the partial failure of new technologies ultimately returned some measure of agency to local users. The turning point came in the 1960s, when three colonial-era infrastructural projects were remade by the postcolonial state: the large dam system in the country's south at Aswan, Cairo's sewer system, and the hydrology of the canal and drainage systems in the country's agricultural fields. These changes fundamentally reoriented the work of managing the river system. Whereas in the earlier period, the river was managed at its highest levels (in flood) and involved the removing of silt from canals, by the second half of the twentieth century, water control focused on managing the river at its lowest levels and managing scour from the now silt-free river. The Aswan High Dam, completed in 1971, established a new hydrological regime by eliminating the annual flood, flattening out the seasonal variation in the river's flow, and ultimately requiring an extensive drainage system to counter the rising water table. Connecting the local surface encounters of water users to the larger infrastructural story demonstrates, then, how a range of engineering practices both created a national hydroscape and, paradoxically, opened new spaces for individual interaction with the overall system.

Keywords: Aswan High Dam, drainage, engineers, expertise, hydrology, infrastructure, irrigation, Nile River, sewers, water

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In mid-October 1969, the Egyptian daily newspaper *al-Ahram* reported that a child had fallen into a sewer drain.[1] According to the article, the five-year-old boy, Khalid, was walking home with his father, a merchant named Sha'ban 'Atiyya Darwish, on the evening of 11 October along Qubba Palace Street in the Zaytun neighborhood of Cairo, when his foot slid into the open drain and he tumbled in. After rescue officials searched drains and pipes frantically for three hours, the boy's body surfaced ten kilometers away at the Amiriyya station. The tragedy of Khalid's body's circulation in the hydraulic system made visible the complex hidden topography of water control, a regime that was changing in the 1960s.

The porosity of dense urban infrastructure had long been a hazard in Cairo; cesspools, an earlier form of sewage management, were often poorly marked in city streets during the nineteenth century—at times people slipped into them and were gravely injured.[2] Unlike the freestanding units of waste collection represented by cesspools, or even urban canals that often carried both waste and drinking water to and from urban dwellings in the nineteenth century, the city's sewers in the 1960s were part of a vast and highly connected system of below-ground pipes, street drains, and newly renovated treatment centers, whose operations were largely coordinated by state officials. Egyptians were increasingly aware that their water needs were serviced as part of a larger and newly configured national system. The country had celebrated the completion of the first stage of construction on a massive hydroelectric dam in the south in May 1964—a project that involved the closure and diversion of the nation's primary water source, the Nile, into a newly dug channel. The closing of the river allowed state officials to impound water from a record-high Nile annual flood that summer, which, with the dam's increasing pressure on the water table, caused massive flooding in Cairo early in the fall of 1964 and again in the spring of 1965. The drains of Cairo—and the substation where Khalid's body surfaced—had been under constant repair over the past four years as a
p. 197 result, as farmers ↳ struggled with waterlogged and salty fields. The local points at which the interconnected hydraulic system erupted to the surface, such as drains in city streets or ditches in rural fields, thus presented points of interaction between the system and many residents, for whom the long stretches of closed water circulation were otherwise invisible.[3]

Although on opposite ends of the water system, dams and drains were integrally connected as forces and even as sites of agency in Egypt's modern hydraulic regime—or the integration of most of the country into a single "hydroscape," a term coined by water politics scholars to refer to the hybrid spaces created through the technology and technological expertise of large-scale projects to manage rivers.[4] How human bodies participate in infrastructure, both formally and informally—as experts, labor, obstacles, and casualties—is crucial to understanding the hydroscape and the nature of power in modern societies. The findings of a series of new studies of Egypt's water history, as well as research through archives, the press, and engineering reports, enable a critical biography of the hydroscape in modern Egypt. Such a biography tracks an arc of change that follows the interplay between local points of opening and control versus the functioning of the larger system: early modern local management within the broader Ottoman system gradually gave way to more centralized control, or at least aspirations of control, by Egyptian and British state officials and experts as they constructed ever-larger water management projects on the Nile in the first half of the twentieth century. Through its partial failure, this new technology ultimately returned some measure of control to local water users by the early twenty-first century.

The 1960s was a crucial turning point in this larger story, as that decade witnessed the remaking of earlier and aging colonial hydrological infrastructure in the capital city (the decrepit sewer system of Greater Cairo originally installed by the British between 1907 and 1915), in the south of the river valley (the new Aswan High Dam that replaced the British-constructed low dam built in 1898–1902), and in the agricultural areas across the country (the canal and drainage systems that linked the river to the fields).[5] These 1960s projects were attempts to accommodate the realities of the postcolonial period—its rapid population growth and the push to transform Egypt from a monocultural agricultural economy into an industrial one—and reoriented work on the river system from removing silt to managing scour. The stories of these different water systems

are usually told separately. The water, however, flows in the hydroscape as a single system, and although the relationship of the system to local points varies, each reflects the evolving struggle between experts and users.

The Water of Egypt: The Nature of Egypt's Hydroscape

Except for a small amount of rainfall along the northern coast and groundwater aquifers supplying oases in
p. 198 the Western Desert, Egypt depends wholly on the water of a single ↳ long river to irrigate its agricultural fields and to provision its villages, towns, and cities. Roughly 96% of water used in Egypt comes from this river, the Nile. Most of Egypt's water is used for agriculture—somewhere between 85 and 90% of the water taken from the Nile in the country. In the year 2000, the industrial sector used another 6% of the water, and municipalities consumed 8% (for personal drinking, household use, etc.).[6] The Nile has historically brought more than just water into Egypt. From the volcanic rocks upstream in Ethiopia, the rains washed rich suspended particulate matter (a mixture of silt, sand, and clay) that has slowly built up the Nile floodplain and the Egyptian Delta.[7] The unpredictability of the river's annual flow is compounded by the variable volume of the river over the "water year" (which runs from July to July on the Nile due to the timing of the flood): over 80% of the water discharged by the river comes during the annual flood, which reaches Egypt between August and October; only 20% of the river's total discharge occurs in the other nine months of the year.[8] The annual flood flushed out toxins and residues from fields and towns and brought new supplies of water into local canals.

While the ecological fact of the need for Nile water and silt has remained constant over millennia, the mechanisms of river control, and its broader context, have altered significantly. As John Waterbury put it in the 1970s, "For 7,000 years, or perhaps longer, the inhabitants of the Nile Valley have been mastering their river in order to master their land. But each technological advance has eventually entailed ecological setbacks."[9] The Middle East has long been linked to theories, such as Karl August Wittfogel's "Oriental despotism," that attribute the rise of powerful, centralized, and bureaucratic states to river control and irrigation works. Tracking the relationships of state to river and of water to power remains a robust mode of inquiry in water politics and environmental history scholarship and continues to inform strands of Middle Eastern history.[10] Whereas scholars once assessed water management through a cause-and-effect model tabulated on a balance sheet, more recent explanations focus on the co-constitution of human and natural change in the Nile Valley as well as the centrality of water management as a force shaping the broader political, socioeconomic, and cultural history of Egypt.[11]

Few scholars have analyzed Egypt's hydroscape as a unit, although many have written biographical studies of the Nile itself or linked Egypt's identity unequivocally with the river. If Herodotus's claim that "Egypt is the gift of the Nile" is the most famous, the colonial epics and more recent Egyptian studies on the relationship of the Nile to Egypt's "national character" are just as influential.[12] Jessica Barnes has noted that these various iterations of hydropolitical analysis, with their focus on governmental expertise, generally neglect the nature of water itself.[13] To track the oscillation in hydroscape governance between centralized and more diffuse user control requires conceptualizing a unit of water landscape that incorporates water as it cycles in the river; in the fields; under the ground; in the sewers, pipes, and drains of urban areas; and even in the bodies of humans, animals, and plants. To do so is not to argue for a totalizing force that overdetermines Egyptian politics and history but rather to follow the water to chart the intersections of fields of power and their change over time.

p. 199 From ancient times until the nineteenth century, irrigation technology was primarily directed to managing the highest levels of the flooding river: building levees, managing flood basins, dredging natural river channels, and erecting small earthen dams and short canals to retain and direct existing flows of water.[14]

These hydraulic works required significant labor and regional coordination, although much of the work of daily water control was performed by individuals or small groups working in specific fields. As Alan Mikhail has demonstrated, the Ottoman imperial state relied heavily on the local knowledge of canal users to determine the engineering works needed to maintain the system. As such, the irrigation network was a site through which, paradoxically, "Egyptian peasants . . . controlled Ottoman bureaucrats—not the other way around—in the determination and execution of repairs to irrigation works in the countryside."[15] The importance of peasant knowledge of local conditions—"a coordinated localism" managed by the imperial center—left a broad scope for agency in the hands of local users of irrigation works, in contrast to the despotic and top-down model of water governance projected by both the Oriental despotism of Wittfogel or the decline narratives of Ottoman history.[16]

Various local and international economic, political, social, and ecological factors radically transformed this regime of fluvial management in the early nineteenth century. The reconstruction of the Mahmudiyya Canal, which carried river water to Alexandria, was a massive state-directed effort completed in 1819–20 at the cost of the lives of one-third of the 300,000 peasants forced to build it.[17] The new local ruler, Mehmet Ali, and his successors continued to develop new hydraulic public works projects and an ever-growing bureaucracy and professionalized engineering corps to support the expansion of summer commercial crops, such as cotton and rice, which require water at times when the flood cycle is low; in other words, they began to manage the river at its lowest levels. Between 1798 and 1833, the land available for summer cropping more than doubled, from 250,000 feddans to 600,000 feddans, supported by 240 miles of deep irrigation canals that the state excavated and had to annually maintain, using compelled peasant labor.[18]

Funneling water from the river into this new canal system remained a challenge, since the valley's slope was so gradual and the water level so low. Throughout the nineteenth century, Egyptian and later British engineers oversaw Egyptian labor to construct new barrages and dig sediment from canals as irrigation on the cycle of the annual river flood (known as "basin irrigation") gave way to year-round or "perennial" irrigation to accommodate the growth of export-oriented agriculture and expand the amount of cultivation to meet the country's growing and urbanizing population.[19] Beginning in the Delta, the conversion to perennial irrigation slowly expanded to Middle and Upper Egypt by the twentieth century, reaching four-fifths of the country by the early 1950s.[20] Perennial irrigation intensified peasant labor and radically altered the ecology of the fields and the river itself: the annual flooding had allowed for washing and aeration of the soil that prevented salt deposits and for natural drainage that kept the water table low, both of which also mitigated against the growth of waterborne parasites, such as those that cause schistosomiasis and
p. 200 hookworm, and the growth of plants that harbored ↳ malaria-bearing mosquitoes and cotton bollworm. This switch in irrigation took a heavy toll on the farmers' bodies, creating, as Jennifer Derr describes it, new "ecologies of pain."[21]

An Early Twentieth-Century Colonial Hydroscape

New agricultural practices increasingly bifurcated management of the rural hydroscape between local users and government officials in the closing decades of the nineteenth century. The branches of government involved in water management grew, and several expanded their purview to other domains.[22] Centralized control of the water commons was not enacted through pricing but through more complex distribution forces. Farmers incurred no charge to use irrigation water, as its cost was covered by the land tax levied on all cultivated land, but its distribution was tightly controlled from its source at the regional level to local canals.[23] The large-scale hydraulic works constructed at the turn of the century, most notably the British dam at Aswan, relocated much of the decision-making about water distribution from farmers into the hands of state employees. While the nationalist movement challenged this consolidation as part of its broader call for political sovereignty, the hydroscape continued to develop as an increasingly complex built space that concentrated control of land, wealth, and local political power.

The distribution of authority in turn-of-the-century irrigation roughly corresponded to the different levels of the canals. As water traveled from the river's main channel into smaller canals, it moved from more centralized control to the domain of local users in four levels of waterways. Government officials, agricultural inspectors, and irrigation engineers, all organized through the Irrigation Department of the Ministry of Public Works (headquartered in Cairo), managed the first three: the main channel or branches of the river, the primary canals, and the secondary (branch or distributary) canals. The frontier of control was the local or tertiary canal, known as the *misqa*.[24] Once the water reached the *misqa*, village officials and local cultivators negotiated the rotation of its movement into individual fields; each *misqa* canal might irrigate 25–30 feddans worth of fields directly through temporary field ditches or furrows.[25] Social power and complex negotiations among local users determined the order to cut and re-block canal banks, operate and direct animal- or human-powered water wheels or other lifting devices, or connect to and operate steam, diesel, or electrical and mechanical pumps.[26] The order of waterings affected both the volume of water available and its quality—as the water moved from the field back to the canal and onto a new field, it became increasingly saline and less nourishing to crops.

Water-lifting technologies to irrigate fields during the low Nile season or those above the reach of canals both changed and expanded in the modern period, transforming patterns of landowning and agricultural
p. 201 work. Employing human and animal labor, ↳ these devices enlarged the role of local end-users in irrigation, perhaps offering more agency but, more importantly, intensifying the labor directed to cropping. Historically, farmers lifted water either through pots, buckets, or scoops attached to long poles (the *shaduf*) or fitted into a water wheel (the *saqiyya*, *tambusha*, or *tabut*), or pumped the water through manual crank pumps, such as the Archimedean screw (the *tanbur*), or automatic pumps powered by steam, diesel, or electric motors.[27] Although water wheels historically had been turned by animal power (mostly oxen, cows, buffalos, and, occasionally, camels), human labor could also be employed when disease and state levies decimated rural stocks of domesticated agricultural animals.[28] Over time, human labor would be replaced by machine labor. By the late nineteenth century, large landowners began to expand away from the older devices lifting water into furrows to the use of motorized pumps feeding pipes under their fields. The environmental forces that shifted labor from animal to human to mechanized lifting power combined with what Ghislaine Alleaume has called the "geometric rationalization of space," produced by developing the new infrastructural grid of irrigation works, to dispossess smallholders. "Large estates were thus the best instruments and the first beneficiaries of the hydro-agricultural revolution in the nineteenth century."[29] The consolidation of large estates through mechanical pumping would transform Egyptian social and political power through at least the mid-twentieth century, if not until today.[30]

The regional developments in irrigation infrastructure became coordinated into a single hydraulic regime with the building of dams at Aswan to store Nile water for summer cropping. British engineers designed the

first, or low, Aswan dam, known as Khazan Aswan, which was built in 1898–1902 with mostly Egyptian labor (roughly ten thousand Egyptians from all over the country), alongside Greek workers and Italian stonemasons, supervised by British engineers. The enormous masonry dam was fitted with 180 sluices that allowed most of the river's floodwater, with its heavy load of silt, to pass downstream; closure of the sluice gates then retained the tail of the flood in the reservoir so that it could be distributed in the spring and summer, when the river level was low. In the first few years, additional engineering projects along the river were required to correct the deep scouring of the fast-moving water released through the dam, and the dam itself had to be widened and supported to prevent its collapse.[31] To meet the growing demand for summer irrigation water, the crest of the dam was raised twice (in 1912 and 1933) in major and complex engineering projects to enlarge its reservoir's capacity, ultimately to 5.7 billion cubic meters, and to build large barrage works downstream to manage the new regime of water discharge (its timing, volume, and velocity) and trap floodwater for regional use in summer cropping: at Asyut (1902), Zifta (1903), Isna (1909), Naj' Hammadi (1930), and Idfina (1951).[32]

Each stage of dam building displaced people living upstream, as the reservoirs flooded the river valley in the area known historically as Nubia. Although somewhat ethnically and linguistically diverse, Nubians had a political, ethnic, and historical identity distinct from both Egyptians and Sudanese. By the 1970s, more than 150,000 Nubians in Egypt and Sudan would be forcibly displaced by the dams to interior land reclamation
p. 202 projects, mostly at Kum Umbu in Egypt and Khashm al-Qirba in Sudan.[33] ↳ Derr has argued that the building of Khazan Aswan marked the ascendency of British colonial irrigation expertise in Egypt by making "permanent the vision of the perennial Nile that was the fantasy of British colonial officials in the late nineteenth century," resolutely linking British colonial officials with colonial capitalists, and marking a transition of sovereignty over the Egyptian hydroscape.[34]

Within a decade, however, nationalist demands for independence would also come to center on Egyptian sovereignty of the Nile's waters, mostly focused on the issue of British-Egyptian control of Sudan and British plans to develop new dams and irrigation works on the river's upstream sources, mainly to store water in less arid environments and to expand the cotton-growing regions of Sudan rather than continue to raise the Aswan dam solely to store additional water.[35] This basin-wide over-year storage program became known after 1920 as the Century Storage Scheme.[36]

Egyptian engineers portrayed this conflict as a contest of national sovereignty, one in which they felt they could directly intervene as individual agents.[37] In 1928, amid this controversy, an Egyptian engineer, Ibrahim Zaki, sent to the local press a pamphlet criticizing upstream British irrigation works, including the Jabal Awliya' project; he titled the forty-eight-page work "Egypt's Enslavement [*isti'bad misr*] by English Irrigation Projects."[38] Compiling a detailed collection of official statements and publications by British and Egyptian irrigation authorities, Zaki argued that "the result of British irrigation projects in the near future is Egypt's perpetual dispossession [*hirman*] of the waters and silt of the Blue Nile and the allocation of that to Sudan" for land reclamation.[39] The dams that the British proposed to construct in Sudan, he claimed, would "rule over the waters of Egypt."[40] Ultimately, a water agreement would be signed in 1929 that would guarantee Egypt water to irrigate all its lands under perennial irrigation (totaling some five million acres at that time) and state that Egypt's water needs would take priority over Sudan's and any other upstream river control projects.[41] The low dam's second heightening, completed in 1933, would be led by an Egyptian industrialist, Ahmad 'Abbud.[42]

Downstream on the Damietta or eastern branch of the Nile in the Delta where Mit Ghamr lies across the river from the town of Zifta, overlapping transformations of irrigation infrastructure revealed the extent to which the river had become almost fully engineered by the state by the early twentieth century. The different types of barrages constructed at this small bend in the river reflected not only the topography of the river's course but also the economic importance and agricultural density of the region, which had long been settled.[43] Mit Ghamr was an old town with a history of robust trade in cotton and cottonseed and the

manufacture of a variety of fabrics.[44] Zifta was also a large regional center for villages on the river's west bank, and it housed an important Coptic church, an international community of traders, and a thriving cotton industry. It supported in the 1880s, according to 'Ali Mubarak, a large agricultural district famous for the variety of crops it produced, including cotton, wheat, barley, maize, fenugreek, lupines, and vegetables on over 3,236 feddans irrigated by water from the Nile and its canals, plus two sweet water springs; eleven waterwheels moved the water from canal to field. It was also the location of a road bridge over the river that
p. 203 served an array ↳ of local villages.[45] One of the early canals was a summer, or *sayfi*, canal called Buhiya Canal, which originated in this region and cut northeast through the eastern Delta, toward Mansoura.[46] In 1885 the state built a temporary stone barrage at Mit Ghamr that funneled "the whole supply of the [Damietta] branch . . . down the canals between 1885 and 1889"; practically no water flowed over the barrage during the summer until the small stone crest at its top was removed to allow the annual flood to pass over it.[47] By contrast, the Zifta Barrage was a permanent elevation barrage built later, in 1903, as part of the downstream works to support the new regime of river regulation made possible by Khazan Aswan.[48]

By 1913, Zifta and Mit Ghamr lay at the crossroads of a series of major canals in the Delta. The Rayyah al-Tawfiqi (one of the three main arterial feeder canals from the Delta Barrages), built in the 1850s and reconstructed in 1887–89 to connect "all the northern canals of the Eastern Delta with the canal system taking off from above the Delta Barrages,"[49] passed through Banha and onto Mit Ghamr, where the Mansuriyya Canal carried the water farther north. Across the river, the Sahil Canal ended at Zifta, and just below the town, the Bahr al-'Abbasi headed northwest toward al-Mahalla al-Kubra. Not far to the west passed the Manufiyya feeder canal. The barrage below Zifta and Mit Ghamr raised the head of the river's branch to fill both the Bahr al-'Abbasi and the Buhiya canals.[50] Landowners constructed large cotton-growing estates, or *'izbas*, in areas serviced by these new summer canals. Moving from his family's estate at Kafr Tanbul, Mustafa Fuuda established his own estate nearby at Balamun in 1927; by 1929, 60% of the villages in the Nile Delta were organized as *'izbas*.[51] As one Egyptian geographer put it in 1961, "The opening decades of the century may well be designated the 'era of dams and barrages.'"[52] These new river works fundamentally altered, even inverted, the Nile's regime so that its "seasons of flood and cultivation are diametrically opposed."[53]

The "Captive Nile" of the 1960s

From 1904 until 1956, the Nile was administered as a single planning unit—as a basin, a construct made possible by the scope of British imperial control of the major territories in the watershed (for the While Nile). This British "water imperialism," Terje Tvedt has noted, allowed "political leaders . . . to regard this widely varying resource as one hydrological and political unit, with far-reaching consequences for the peoples who for generations had been living along the banks of the river as if the river and its tributaries were local water courses."[54] The building of the Aswan High Dam (al-Sadd al-'Ali) at midcentury, however, altered the relationship of Egypt to the Nile Basin politically and materially.

The High Dam allowed the state to remake the Nile into a national river by creating a new river "source" (its reservoir, Lake Nasir) largely within the bounds of the nation and generating a fixed "artificial flood" each
p. 204 year.[55] In other words, the High Dam, in the ↳ 1950s and 1960s, turned the water system of Egypt into a national hydroscape through two radical changes to the administration of the Nile. First, nationalist agitation finally succeeded in fully eliminating the British colonial presence in Egypt, in large part through the nationalization of Egyptian waterways—both the Nile, via the building of the High Dam to conserve over-year storage within Egypt's national boundaries, and the Suez Canal, nationalized in 1956 to provide local funding for the High Dam project and establish the local and international political authority of the country's anticolonial revolution and its leader, Gamal Abdel Nasser. Second, the High Dam's capture of the full discharge of the annual flood changed the entire downstream hydrological regime: it flattened out the

water flow's seasonal variation and altered its content. Irrigation officials no longer struggled with dredging silt from the canals but now had to contend with the clear-flowing water (its speed, lack of sediment, and waterlogging).

The new hydrological regime's effect on drains in fields and cities was profound. Cairo's old colonial-era sewer system largely collapsed in the 1960s, requiring massive restructuring and rebuilding, and drainage facilities became the primary target of national and international water experts attempting to rescue Egyptian fields from waterlogging and salinization. While the High Dam seemed to offer the Egyptian state full centralized control of the release and flow of Egypt's water, these secondary effects on the hydroscape slowly returned some control to local users in Egypt's fields and cities.

The High Dam functioned as an important technology and symbol of Egypt's postcolonial transition. Signaling the nation's independent sovereignty, the dam provided the new regime with a dramatic opportunity to assert postcolonial independence and position itself within an emerging system of Cold War "development."[56] Exponential population growth also drove international donor experts and Egyptian officials to build the dam: feeding a growing population within the limits of the Nile Valley demanded both expansion of arable land and further intensification of existing cultivated land by increased irrigation. By the 1950s, Egypt's population had doubled from about 10 million since Khazan Aswan opened and was projected at that time to grow at 2.5 to 3% annually; by 1960, it reached 26 million and was expected at that time to reach about 70 million in 1993.[57] Egypt's cities especially grew enormously larger and denser in the 1950s and 1960s, aided by rapid migration from the overburdened agrarian zones as well as sanitation and medical reforms that lengthened urban residents' life expectancy, especially in Cairo.

Increasing agricultural resources to support the growing population dovetailed with the perceived need to fully regulate the discharge of the river by "mastering" the annual flood: gaining control of all the river's discharge (water and silt) as well as regularizing its release across the seasons and from year to year. Even with the expanded irrigation grid, by midcentury, almost 40% of the river water flowed into the Mediterranean Sea during the yearly flood season.[58] Irrigation officials condemned this discharge into the sea "as waste" of a needed resource.[59] Just as important was standardizing the irregular volume of the annual flood. Although the average measured annual discharge of the Nile in the century between 1878 and 1977 was 84 billion cubic meters, the flow had ranged in that period between nearly double that volume (155 billion cubic meters in 1878–79) and half ↳ of it (42 billion cubic meters in 1913–14).[60] The shift from seasonal to over-year storage made possible by the High Dam would finally manage this unpredictability in volume and permit greater water distribution for summer cropping. Equally significant was the elimination of silting to block water flow in downstream canals. As one foreign policy expert put it in the years after the High Dam opened, a new "captive Nile" had emerged.[61]

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The High Dam was built four miles upstream of Khazan Aswan at the first cataract on the Nile. An enormous rock-fill dam, it is often described as an engineering feat, either by reference to its metrics (111 meters high; a kilometer broad at the base; 3.8 kilometers long at the top; requiring 42.7 million cubic meters of construction materials; creating one of the largest reservoirs in the world) or to its monumentality, and likened to other natural and human-created "wonders."[62] Writing in the late 1970s, Richard Benedick presented the dam using both strategies: "By any standards, the Aswan High Dam is one of the engineering wonders of the world; there is no comparable structure in terms of impact on the life of an entire country. One of the world's largest man-made constructions, it is a veritable artificial mountain of rock and sand; here, at the first cataract of the Nile and the traditional southern outpost of the pharaohs before the sands of Nubia, modern Egypt erected a gargantuan quasi-pyramidal structure 17 times larger in volume that the Great Pyramid of Giza."[63] On the dam's east side, the hydroelectric powerhouse sits across the diversion channel. The turbines were installed between 1968 and 1970, and the powerhouse reached total power production in the middle 1980s. In 1974, before the country had developed other significant sources of power, the dam supplied 53% of Egypt's total electric power use; much of that power went to service a new

fertilizer plant, in part to replace the nutrients lost to Egypt's soils due to the dam and the overall irrigation regime, in addition to servicing chemical plants at Aswan and providing electricity downstream in Cairo, Alexandria, and Port Said, along with some villages.[64]

Historians have argued that the political "battle of the high dam" to secure funding and establish a new water rights convention was "harsher" than the battle against nature in the technical struggle to build the dam.[65] Nevertheless, the actual construction project, first managed by Soviet hydraulic expertise and later largely transitioned to Egyptian engineering firms, including 'Uthman Ahmad 'Uthman's Arab Contractors, was massive and stretched over the 1960s.[66] At the height of construction in 1962–63, more than thirty thousand workers labored under harsh and often dangerous conditions at the site.[67] The dam's construction entirely remade the region of Aswan as a whole, including the forced relocation of residents and the more-publicized rescue of ancient monuments behind the dam in historic Nubia.

Full regulation of the streamflow and end of the annual flood fundamentally altered the hydroscape and its management.[68] In material terms, the dam's retention of the river's silt radically reordered the kinds of labor and maintenance required by the irrigation network. After two centuries or more of forcing Egyptian laborers to dredge canals of built-up sediment, the water downstream of Aswan flowed nearly clear, not silting up the irrigation grid but rather cutting into its banks with its newfound velocity.[69] New elements of
p. 206 the hydraulic infrastructure were constructed, and older barrages ↳ were shored up. The state built a new feeder canal, the Nubariyya, in the western side of the Delta and established new pumping works northwest of Cairo in Tahrir Province, both with the goal of converting desert to agricultural land, although, ultimately, these projects were not fully successful because the quality of the soils and the topography caused waterlogging or prevented successful cultivation.[70] The temporality of canal labor also changed: canals were closed for only one week rather than three each year for cleaning and rehabilitation, which led to increased waterlogging of fields. Also, the diminished turbidity and different quality of the water (higher levels of dissolved solids and phytoplankton) coming down the river led to the growth of aquatic vegetation (including water hyacinths) that needed clearing rather than silt.[71]

The state expected that the High Dam would expand the agricultural area of Egypt by reclaiming 1.3 million feddans and allow for the conversion of 700,000 feddans from basin to perennial irrigation, thereby increasing the productivity of these lands. Specifically, it aimed to expand the area under cultivation for rice—a water-intensive crop that can be used in land reclamation—as well as to improve conditions for navigating the Nile year-round.[72] The new hydraulic regime led to a return to state control over the crop mix in the 1950s and 1960s, which was enforced through the "nation-wide cooperative system established in 1963."[73] Agricultural expansion, ultimately, was much less than predicted: in fact, the amount of cultivated land declined between 1960 and 1975 from more than 6 million to 5.9 million feddans, due to the expansion of building in Cairo and the Delta; the conversion of about 120 square kilometers annually of agricultural land to soil harvested for brickmaking once annual silt deposits disappeared; and the high salinity of some agricultural land, which compromised its fertility. Some of this land loss was offset by the intensification of land cultivation; croppings, for example, expanded from 9.3 million feddans in 1952 to 11.2 million feddans in 1982.[74] The technical feat of channeling and controlling the water's entire flow also necessitated new international agreements to determine the exact amount of the Nile's water that Egypt could claim. The British Empire's control over both Egypt and Sudan in the early twentieth century had facilitated this division; the first postcolonial agreement was signed by Nasser in Cairo on 8 November 1959. The Agreement for the Full Utilization of the Nile Waters between Egypt and Sudan gave Egypt a fixed annual share of Nile water—55.5 billion cubic meters (bcm).[75]

Draining Egypt's Waterlogged Fields and Cities

The expansion of perennial irrigation's highly engineered and increasingly centralized hydraulic network led in turn to the growth of an equally complex and extensive network of artificial drainage to serve Egypt's fields and maintain their fertility by removing water pooled at the surface and lodged near plant roots.[76]

p. 207 According to Gamal Hamdan ↳ in 1961, "Until World War I, drainage was a very secondary question, but has since leapt into the forefront. Everywhere, the fellah now asks for a drain."[77] Field drainage was modified in two primary ways in the twentieth century: expanded spatially to maintain soil quality and pushed underground to free up more surface land for cultivation. Field drainage infrastructure soon became nearly as extensive as the system that brought fresh water to the fields, especially once flushing by the annual flood stopped in the 1960s.[78] Moreover, the gradual slope of the Delta toward the north and the fact that much of the land near the coast was below sea level required the establishment of electric pumping stations to push drainage water into the sea, since gravity alone could not discharge it.

Early field ditch drains reduced the amount of land that could be farmed, thus directly undermining the irrigation system's very goal of agricultural expansion. By the 1960s, this loss of valuable land had become acute, even reaching one-tenth of each field.[79] Pipe drains, which lay underground in the fields in soil-covered trenches, were increasingly installed in the second half of the twentieth century to prevent land and water waste.[80] Subsurface drainage through pipes, then, reversed land loss and worked more effectively, as it did not need to be cleared of weeds and other materials that could hamper water flow in open ditches. It was, however, expensive and required more specialized technologies for installation and maintenance.[81] There were also other limits to drains. Within individual fields, drains created an uneven cultivation geography, since drainage efficiency diminished across individual fields: while cotton could be grown on either side of a drain, field edges could support only reclamation crops, such as rice.[82] By 1971, the drainage network was substantial throughout the country.[83] By the 2010s, about 60% of Egypt's agricultural land was served by subsurface drainage and 40% by surface drains.[84]

Drainage technology came increasingly under state control after the late nineteenth century to compel implementation by smaller landholders, who were less willing to convert usable land to drainage.[85] Over time, however, drainage networks became less centralized, marking a sharp shift away from the river control and irrigation networks, which remained concentrated under state authority. The power of a large dam, Barnes argues, "stems from the concentration in space of the technologies for managing the flow of water through the country. . . . In contrast, while the subsurface drainage program has made Egypt's subterranean flow controllable, it is a diffuse network of control. There are nodal points—the manholes for inspection, the joints between different pipes—but there is no one site where this flow can be turned on and off."[86] Despite the increasing diffusion of control, drainage brought a new generation of international water experts into Egypt's hydroscape. In 1971, just as the High Dam was officially completed, the World Bank began a series of US-funded subsurface drainage projects to reclaim Delta farmland, a program that eventually grew to include other partners (such as the Netherlands and European and African funders) and has continued into the 2000s and expanded out of the Delta to become national in scope.[87] Thus, the new national hydroscape, brought into being by the High Dam, ultimately invited a new form of neoliberal international water expertise to "fix" its ecological consequences.

p. 208 The river control and irrigation networks that compromised drainage in Egypt's fields also affected the circulation of water in Egypt's cities. When Khalid fell into Cairo's sewer in 1969, the city's drains were undergoing repair as part of an ongoing process to manage the system after the construction of the Aswan High Dam. Cairo's drains were part of a combined system that carried both runoff water and sewage out of the city and ran separately from a parallel grid to supply fresh water from the river and, to a lesser extent, from deep-welled aquifers, for drinking, cleaning, or industrial uses by urban residents.[88] The upstream dams, the cessation of the annual flood, and the lack of field drainage increasingly put pressure on the

country's water table. Its unmanageable rise, along with other factors, caused segments of the urban water system of Cairo, originally installed by the British between 1907 and 1915, to collapse by 1965. The failure of the sewer systems is often recounted as a coda to histories of Cairo to preview the wider breakdown of the city's infrastructure due to population expansion and massive in-migration from the countryside, as well as the limits of socialist planning under Nasser and the corruption that followed in Anwar al-Sadat's and Husni Mubarak's eras. This narrative is almost always part of a story of disease and public health.[89] However, river control and urban water projects were interlinked in important ways in the 1960s, including their colonial legacies.

The British sewer project and the properties of the urban hydroscape that came into the state's view during its design and construction were largely prompted by colonial anxieties about the health of locally resident foreigners and concerns over the repeated disease epidemics of the late nineteenth century. As Shehab Ismail documents convincingly, the cholera epidemics between 1883 and 1902 led to increasing scrutiny of the nature of Cairo's subsoil, the routes of human waste disposal and potable water provision within it, and the relationship of those routes to the Nile itself. Proposals for new sanitary infrastructures, both sewage systems and sources for drinking water, entailed a series of intertwined decisions about the relationship of the two water systems through underground drainage into the river. Both water provisioning and sewage removal deepened "a bifurcated urban landscape" in the city, which was marked by colonial assumptions about consumption according to class and culture.[90] As Ismail notes, the decisions and designs in constructing the new colonial sewers were political acts intended to "civilize" Egyptians. According to liberal European engineers, "sanitary uplift" would be created by the expansion of domestic privacy in plumbing and the decline of more collective hygiene.[91] Limited to certain sectors of the city and its capacity overdetermined by racialized assumptions about consumption and cleanliness, the new colonial system was insufficient from the outset, even as it remade portions of the cityscape.

The city flooded twice in the "water year" of 1964–65. While urban flooding was not unknown in Cairo—a particularly wide-scale collapse of the sewers had occurred in 1934[92]—this year, 1964–65, was unusual for several reasons: urban flooding occurred both during high and low points of the river, while the nation celebrated its technical mastery of its hydrological regime with the completion of the first stage of High
p. 209 Dam ↳ construction. A long-term increase of the groundwater table was largely to blame. According to Egyptian geologists in the late 1970s and 1980s, Egypt's water table rose between 1930 and 1980 from a depth of fourteen meters from the surface to less than five meters from the surface. By 1980, the water table in Cairo, for instance, was less than two meters below the surface.[93]

The first flooding of the streets of Cairo in the water year occurred in September 1964. Just months after the diversion of the Nile River into the channels for High Dam construction, the river produced its largest flood of the century, and by the end of September, the Nile ran two meters higher than the city.[94] In April 1965, many of the same streets were again inundated with sewage as the city flooded a second time, mostly due to a collapse of the drainage system. The old pipes and pumping stations in many districts of the city could not keep pace with the surging sludge that urban expansion and population growth produced. The flooding hit several of Cairo's low-lying neighborhoods the hardest. The 1964–65 urban floods and overflows prompted the emergency formation of the Permanent Cairo and Giza Drainage Committee to oversee the "hundred-day drainage projects" to repair the city's sewerage grid in the spring of 1965.[95] The committee was chaired by the state's minister of electric power, 'Izzat Salama, who represented perhaps the highest level of state infrastructure, the High Dam. Completing major projects nearly a month ahead of schedule, in July the committee oversaw the inauguration of new drainage projects in Giza and in the "northern districts" of Cairo, as well as pipeline repairs on major streets. Salama and his engineers declared their total control of the urban waterscape in 1965, although drainage problems continued well into the 1980s and even plague the city to this day.[96]

The Future of Hydro-Irregularity

Widely fluctuating Nile flood levels in the 1970s and early 1980s convinced many Egyptians that eliminating the annual flood by impounding the river's waters in the reservoir had "saved the country." In the early 1980s, a series of low Niles brought widespread drought to much of eastern Africa. Many Egyptians believed that the High Dam prevented drought in Egypt since the dam's reservoir had filled earlier than expected due to record-high floods in 1964 and 1975.[97] The reservoir replenished thanks to more regular rains in the 1990s, although, by the 2000s, the problem had become one of excess water in years of strong flooding. State officials, worried about raising farmers' expectations of more water, for instance, or about damage to the infrastructure below the dam, have in recent years diverted excess river water to the desert to evaporate rather than send it downstream.[98] Regardless of stored capacity, the state releases the same amount of water each year. Control of the Nile's waters has re-emerged as an area of international conflict and struggle. The Grand Ethiopian Renaissance Dam (GERD) has been under construction in the headwaters of
p. 210 the Blue ↳ Nile (responsible for the bulk of the water of the Nile in Egypt) in the highlands of northern Ethiopia since 2011, although its impact on the Egyptian hydroscape remains unclear.[99] As such, Egypt faces problems of both water scarcity and water abundance in the twenty-first century.[100]

Widening the view of Egypt's hydraulic regime, therefore, brings together water narratives that are usually recounted and even experienced separately. Since the early modern or Ottoman period, control of Egypt's irrigation regime had been shifting from forms of local control and expertise to more centralized state coordination of the system as the fluvial environment was increasingly engineered into a new hydraulic regime, one governed by new seasonal cycles and water tempos as much as a new and expanded logic of control. However, the failures of the large dams in the country's south, such as waterlogging, scouring of the riverbed, and lower yields due to salinity and nutrient loss in fields, paradoxically shifted water system control back to the end-users over the following half century. The ongoing struggle becomes visible by tracking the transformation and management of Egypt's hydroscape along narrative registers of both the local surface encounters and the broad infrastructural system that emerged in direct conflict in the 1960s. The "captive Nile" and its new artificial flood also fundamentally reordered the work of irrigation from clearing silt to managing swift water that scoured banks and barrages and refused to drain from fields.

Increased centralized control by the state unified the country into a national hydroscape and led to global changes in water politics. The new centralized regime of water management that emerged between 1898 and 1971 "represented [one] of the most powerful transformations of the twentieth century," according to Timothy Mitchell. "The building of the original barrage at Aswan in 1898–1902 helped inaugurate around the world an era of engineering on a new scale. Schemes to block the flow of large rivers were to become the century's largest construction projects. Dams were unique in the scope and manner in which they altered the distribution of resources across space and time, among entire communities and ecosystems. . . . For many postcolonial governments, this ability to rearrange the natural and social environment became a means to demonstrate the strength of the modern state as a techno-economic power."[101] As each new technological stage of fluvial management invited more and different forms of intervention, a paradoxical alignment of a strong state and diffuse control brought new actors into water control. It is this engineered and hybrid quality that most firmly marks the hydroscape in modern Egypt. The awkward and contradictory locations for human agency in this system come in and out of view at crucial junctures but, nevertheless, remain deeply connected as forms of power.

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Notes

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1. "Tifl Yasqut fi Balu'a; al-Miyah Tajrufuhu 10 Kilumitrat," *al-Ahram*, 12 October 1969, 9.

2. Khaled Fahmy, "An Olfactory Tale of Two Cities: Cairo in the Nineteenth Century," in *Historians in Cairo: Essays in Honor of George Scanlon*, ed. Jill Edwards (Cairo: American University in Cairo Press, 2002), 175, 185 note 55.

3. Brian Larkin, "The Politics and Poetics of Infrastructure," *Annual Review of Anthropology* 42 (2013): 327–43.

4. Ravi Baghel, *River Control in India: Spatial, Governmental and Subjective Dimensions* (New York: Springer 2014), 17. Marcus Nüsser delineates a genealogy for the term *technological hydroscapes* in *Large Dams in Asia: Contested Environments between Technological Hydroscapes and Social Resistance* (New York: Springer, 2014), 6. See also Erik Swyngedouw, *Liquid Power: Contested Hydro-Modernities in Twentieth-Century Spain* (Cambridge, MA: MIT Press, 2015).

5. On the 1960s as the global highpoint of dam building, see J. R. McNeill, *Something New under the Sun: An Environmental History of the Twentieth-Century World* (New York: W. W. Norton and Co., 2000), 159.

6. Hosam E. Rabie Elemam, "Egypt and Collective Action Mechanisms in the Nile Basin," in *River Nile in Post-Colonial Age: Conflict and Cooperation among the Nile Basin Countries*, ed. Terje Tvedt (New York: I. B. Tauris, 2010), 219; Jessica Barnes, *Cultivating the Nile: The Everyday Politics of Water in Egypt* (Durham, NC: Duke University Press, 2014), 1, 5; *Food and Agriculture Organization of the United Nations*, AQUASTAT country report for Egypt, 2016, accessed 15 July 2019, http://www.fao.org/nr/water/aquastat/countries_regions/EGY/print1.stm.

7. John Waterbury, *Hydropolitics of the Nile Valley* (Syracuse, NY: Syracuse University Press, 1979), 24; Gamal Hamdan, "Evolution of Irrigation Agriculture in Egypt," in *A History of Land Use in Arid Regions*, ed. Laurence Dudley Stamp (Paris: UNESCO, 1961), 136; John Cooper, *The Medieval Nile* (Cairo: American University in Cairo Press, 2014), 1.

8. Waterbury, *Hydropolitics*, 22–23.

9. Ibid., 12.

10. For a discussion of these trends, see Alan Mikhail, *Nature and Empire in Ottoman Egypt* (Cambridge: Cambridge University Press, 2011), 16–17, 31–34; and Jennifer L. Derr, *The Lived Nile: Environment, Disease, and Material Colonial Economy in Egypt* (Stanford: Stanford University Press, 2019), 68–69.

11. Alan Mikhail, *Under Osman's Tree*: *The Ottoman Empire, Egypt, and Environmental History* (Chicago: University of Chicago Press, 2017), 19; Timothy Mitchell, "Can the Mosquito Speak?" in *Rule of Experts: Egypt, Techno-Politics, Modernity* (Berkeley: University of California Press, 2002).

12. River epics range from Emil Ludwig's *The Nile: The Life-Story of a River*, originally published in Dutch in 1935 and then English translation in 1937 (Crows Nest, Australia: Allen & Unwin), to works such as Robert Twigger, *Red Nile: A Biography of the World's Greatest River* (New York: St. Martin's Press, 2013) or Egyptian geologist Rushdi Sa'id's *Nahr al-Nil*, 2nd ed. (Dar al-Hilal; Oxford: Pergamon Press, 2001). On the Nile and Egypt's character, see Amin Sami's multivolume *Taqwim al-Nil*, published in Cairo between 1916 and 1936, and Gamal Hamdan's four-volume *Shakhsiyyat Misr: Dirasa fi 'Abqariyyat al-Makan*, published in Cairo in the 1980s.

13. Barnes, *Cultivating the Nile*, 26. See also Ben Orlove and Steven C. Caton, "Water Sustainability: Anthropological Approaches and Prospects," *Annual Review of Anthropology* 39 (2010): 404.

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14. Karl C. Butzer, *Early Hydraulic Civilization in Egypt: A Study in Cultural Ecology* (Chicago: University of Chicago Press, 1976), 47.

15. Mikhail, *Nature and Empire in Ottoman Egypt*, 62.

16. Ibid., 33; Mikhail, *Under Osman's Tree*.

17. Mikhail, *Nature and Empire*, 242–90; Cooper, *Medieval Nile*, 48–74.

18. Derr, *The Lived Nile*, 17.

19. H. E. Hurst, *The Nile* (London: Constable, 1952), especially chapter 3; Nicholas S. Hopkins, "Irrigation in Contemporary Egypt," in *Agriculture in Egypt: From Pharaonic to Modern Times*, ed. Alan K. Bowman and Eugene Rogan (Oxford: Oxford University Press, 1999), 367–85. This notion of the "perennial Nile" is the premise of Derr, *The Lived Nile*.

20. Hurst, *The Nile*, 46.

21. Derr, *The Lived Nile*, 6.

22. For the various ministries involved in Egypt's water management, see Barnes, *Cultivating the Nile*, 17.

23. Hurst, *The Nile*, 65; Yusuf A. Shibl, *The Aswan High Dam* (Beirut: Arab Institute for Research and Publishing, 1971), 43.

24. Hurst, *The Nile*, 65.

25. Ibid.

26. Nicholas S. Hopkins, *Agrarian Transformation in Egypt* (Boulder, CO: Westview Press, 1987), especially chapter 7; Barnes, *Cultivating the Nile*; Hurst, *The Nile*, 42–45; Derr, *The Lived Nile*, 101–3.

27. Hurst, *The Nile*, 42–45; Derr, *The Lived Nile*, 101–03; Ahmad al-Hitta, *Tarikh al-Zira'a al-Misriyya fi 'Ahd Muhammad 'Ali al-Kabir* (Cairo: Dar al-Ma'arif, 1950), 14.

28. Alan Mikhail, *The Animal in Ottoman Egypt* (Oxford: Oxford University Press, 2014), 39.

29. Ghislaine Alleaume, "An Industrial Revolution in Agriculture? Some Observations on the Evolution of Rural Egypt in the Nineteenth Century," in *Agriculture in Egypt*: *From Pharaonic to Modern Times*, ed. Alan K. Bowman and Eugene Rogan (Oxford: Oxford University Press, 1999), 338.

30. Samera Esmeir, *Juridical Humanity: A Colonial History* (Stanford: Stanford University Press, 2012); Derr, *The Lived Nile*.

31. On the building of the low dam, see Derr, *The Lived Nile*, chapter 2; and Waterbury, *Hydropolitics*, 33.

32. Waterbury, *Hydropolitics*, 3.

33. Hussein M. Fahim, *Egyptian Nubians* (Salt Lake City: University of Utah Press, 1983).

34. Derr, *The Lived Nile*, 72–73.

35. Ibid., 61–64.

36. Waterbury, *Hydropolitics*, 64.

37. On the general political and nationalist furor of the 1920s around the Jabal Awliya' dam on the White Nile, see Robert L. Tignor, "Nationalism, Economic Planning, and Development Projects in Interwar Egypt," *The International Journal of African Historical Studies* 10, no. 2 (1977): 185–208.

38. The full title of the pamphlet was *Isti'bad Misr bi-Mashru'at al-Rayy al-Injliziyya*. *Isti'bad* may also be translated as "subjugation," although the British Interior Ministry officials in Cairo chose to translate it as "Enslaving Egypt by British Irrigation Projects" when they forwarded a copy of the Arabic pamphlet to the British Embassy in Cairo in November 1928. The British prided themselves on abolishing slavery in Egypt as part of their civilizing colonial mission, as well as abolishing forced (corvée) labor. On Egypt's relationship to ↳ Sudan, especially under British occupation, see Eve Troutt Powell, *A Different Shade of Colonialism* (Berkeley: University of California Press, 2003). The pamphlet is enclosed in The British National Archives, London, Kew (TNA), Foreign Office (FO) 141/577/C376586, Cairo, 8 November 1928, Keown-Boyd to Smart/High Commissioner.

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39. Zaki, "Ist'bad Misr," 16.

40. Ibid., 23.

41. Derr, *The Lived Nile*, 64.

42. Robert Vitalis, *When Capitalists Collide: Business Conflict and the End of Empire in Egypt* (Berkeley: University of California Press, 1995).

43. These towns appear across the river branch (then the Tinnis branch) on al-Idrisi's map of the Delta in 1154. See Cooper, *Medieval Nile*, figure A1.7.

44. 'Ali Mubarak, *al-Khitat al-Tawfiqiyya al-Jadida li-Misr al-Qahira wa-Muduniha wa-Biladiha al-Qadima wa-l-Shahira*, vol. 16 (Bulaq: al-Matba'a al-Kubra al-Amiriyya, 1886), 79–80. The town at that time was named Minya al-Ghamr; on the name change, see Muhammad Ramzi, *al-Qamus al-Jughrafi li-l-Bilad al-Misriyya min 'Ahd Qudama' al-Misriyyin ila Sanat 1945*, part 2 (Cairo: al-Hay'a al-Misriyya al-'Amma li-l-Kitab, 1994), 263.

45. Mubarak, *al-Khitat*, vol. 11, 95.

46. Rivlin, *Agricultural Policy*, 232.

47. Willcocks and Craig, *Egyptian Irrigation*, vol. 2, 631–32.

48. Shibl, *Aswan High Dam*, 39. The Zifta Barrage is illustrated in Willcocks and Craig, *Egyptian Irrigation*, vol. 2, facing 664 in plate 164.

49. Willcocks and Craig, *Egyptian Irrigation*, vol. 2, 572.

50. Ibid., vol. 1, plate 31 (Map of Lower Egypt and the Fayum).

51. Mona Abaza, *The Cotton Plantation Remembered: An Egyptian Family Story* (Cairo: American University in Cairo Press, 2013), 82.

52. Hamdan, "Evolution of Irrigation Agriculture," 127.

53. Ibid.

54. Tvedt, *The River Nile in the Post-Colonial Age*, 3.

55. United Arab Republic, Maslahat al-Ist'lamat, *The High Dam: Bulwark of Our Future* (Cairo: Ministry of Information, 1963), 6.

56. Ahmad Shokr, "Hydropolitics, Economy, and the Aswan High Dam in Mid-Century Egypt," *Arab Studies Journal* 17, no. 1 (2009): 9–31.

57. Gilbert F. White, "The Environmental Effects of the High Dam at Aswan," *Science* 30, no. 7 (1988): 6.

58. Richard Elliot Benedick, "The High Dam and the Transformation of the Nile," *Middle East Journal* 33, no. 2 (1979): 122; Hamdan, "Evolution of Irrigation Agriculture," 140.

59. See, e.g., Hamdan, "Evolution of Irrigation Agriculture," 125, 140; and UAR, Maslahat al-Ist'lamat, *The High Dam*, 6–8.

60. John Waterbury, *The Nile Stops at Aswan*, part 1 (Hanover, NH: American Universities Field Staff, 1977), 10.

61. Benedick, "The High Dam," 127.

62. See Waterbury, *Hydropolitics*, Table 8: "The High Dam in Figures," 111.

63. Benedick, "High Dam," 123; Waterbury, *Hydropolitics*, 111.

64. White, "Environmental Effects," 11.

65. Tahir Abu Fasha, *Qissat al-Sadd al-'Ali*, 2nd ed. (1960; reprint, Cairo: General Authority for Cultural Palaces, 2010), 61.

p. 214 66. Elizabeth Bishop, "Talking Shop: Egyptian Engineers and Soviet Specialists at the Aswan High Dam" (PhD diss., University of Chicago, 1997).

67. Alia Mossallam, "We Are the Ones Who Made This Dam 'High'! A Builders' History of the Aswan High Dam," *Water History* 6, no. 4 (2014): 297–314.

68. Abdelazim Negm, Mohamed Elsahabi, and Mohamed Salman Tayie, "An Overview of Aswan High Dam and Grand Ethiopian Renaissance Dam," in *Grand Ethiopian Renaissance Dam Versus Aswan High Dam: A View from Egypt*, ed. Abdelazim M. Negm and Sommer Abdel-Fattah (Cham, Switzerland: Springer Nature, 2019), 7.

69. S. Shalash, "The Effect of the High Aswan Dam on the Hydrological Regime of the River Nile," *IAHS-AISH Publication* 130 (1980): 244.

70. White, "Environmental Effects," 34.

71. Ibid., 11, 35–36.

72. United Arab Republic, Ministry of National Guidance, *The Yearbook 1966* (Cairo: Information Administration, 1966), 97–98.

73. Roger Owen, "A Long Look at Nearly Two Centuries of Long Staple Cotton," in *Agriculture in Egypt*, 356–57.

74. White, "Environmental Effects," 11, 34. The figures for "cropped land" are obtained by "counting land cultivated in each crop season separately," 34.

75. Elemam, "Egypt and Collective Action," 219; Waterbury, *Hydropolitics*, 72–73; Tvedt, *The River Nile*, 7.

76. Barnes, *Cultivating the Nile*, 141.

77. Hamdan, "Evolution of Irrigation Agriculture," 129.

78. Hurst, *The Nile*, 63–64; Hamdan, "Evolution of Irrigation Agriculture," 129.

79. Hamdan, "Evolution of Irrigation Agriculture," 129.

80. Hurst, *The Nile*, 64.

81. Barnes, *Cultivating the Nile*, 147–50.

82. Hamdan, "Evolution of Irrigation Agriculture," 133.

83. Shibl, *Aswan High Dam*, 39–40.

84. Barnes, *Cultivating the Nile*, 143.

85. Ibid., 147.

86. Ibid., 158.

87. Ibid., 149.

88. André Raymond, *Cairo*, trans. Willard Wood (Cambridge, MA: Harvard University Press, 2000), 358.

89. Janet Abu-Lughod, *Cairo: 1001 Years of the City Victorious* (Princeton, NJ: Princeton University Press, 1971); Raymond, *Cairo*; Shehab Ismail, "Engineering Metropolis: Contagion, Capital, and the Making of British Colonial Cairo, 1882–1922" (PhD diss., Columbia University, 2017).

90. Ismail, "Engineering Metropolis," 155. See also Shehab Ismail, "Epicures and Experts: The Drinking Water Controversy in British Colonial Cairo," *Arab Studies Journal* 26, no. 2 (2018): 8–42; and Ismail, "Engineering Heterotopia," *International Journal of Middle East Studies* 47 (2015): 566–69.

91. Ismail, "Engineering Metropolis," 274.

92. "Cairo's Drainage System Breaks Down; Serious Privations Menace Flooded City," *The New York Times*, 17 September 1934,

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94. See *al-Ahram*, 24 September 1964, 3.

95. On the constitution of the committee and discussion in the People's Assembly, see "Miyah al-Tafh Satakhtafi fi al-Qahira wa-l-Giza," *al-Ahram*, 29 April 1965, 6.

96. "Aly Sabry Opens 'One-Hundred-Day' Drainage Projects," *Egyptian Gazette*, 21 July 1965, 2; Raymond, *Cairo*, 358–59; Christophe Boltanski, "Rehabilitation des égouts du Caire," *Observatoire Urbain du Caire Contemporain, CEDEJ: Lettre d'information* 14 (1988): 8–9.

97. "Drought Averted Thanks to H. Dam," *Egyptian Gazette*, 23 July 1985, in clippings file, Thomas Naff papers, The Middle East Water Collection, Oregon State University Libraries, Oregon Digital, accessed 7 September 2020, https://oregondigital.org/downloads/f0df70q408p?file=thumbnail. On the earlier than expected filling of the reservoir, see also White, "Environmental Effects," 7–8.

98. Barnes, *Cultivating the Nile*, chapter 2.

99. On the GERD struggle, see Negm and Abdel-Fattah, eds., *Grand Ethiopian Renaissance Dam Versus Aswan High Dam*; and Muhammad Saliman Tayi', *Misr wa-'Azmat Miyah al-Nil* (Cairo: Dar al-Shuruq, 2012).

100. Barnes, *Cultivating the Nile*, 138–39.

101. Mitchell, "Can the Mosquito Speak?," 21.

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