The Dams at Aswan: Does Environmental History Inform Decisions?

The revolutionary government of Egypt under Gamal Abdel Nasser announced in 1952 its decision to build a high dam on the Nile River at Aswan. Since the project's completion, it has been acclaimed a national treasure and criticized as an ecological catastrophe. It illustrates the principle that dams "are not just engineering works but also constitute social institutions."[1] Assessment of the dam's social and environmental effects shows mixed results and indicates a missing element in many development projects: a careful examination of perspectives that environmental history could provide.

The Aswan High Dam represents a massive break with the past, and as in all such cases, it had results beyond those intended by its planners. It is 364 feet high, its length across the valley is more than two and one-third miles, and its reservoir, Lake Nasser/Nubia, can hold two years' average flow of the Nile. The dam ended the annual flood and converted the river below it into an open aqueduct.

There were several purposes of Nasser's decision to impose such a traumatic alteration on the Nile and the people who depend on it. All Egypt's cropland is irrigated. The dam would make perennial irrigation, and a second or third crop possible on all cultivated land. The additional production would be in export crops, especially cotton, sugar, and rice. There would be water to expand cropland by as much as two million acres. Maintaining food production to feed Egypt's growing population was one goal, but subsidiary: in fact Egypt, largely self-sufficient before the High Dam, now imports 70 percent of its food. A second function of the dam was generation of electric power for industrialization. A third purpose was containment of large floods.

[1]Hussein M. Fahim, *Dams, People and Development: The Aswan High Dam Case* (New York: Pergamon Press, 1981), p. 4.

Hydraulic engineers knew these three purposes would interfere with each other. It is impossible to maximize two independent variables over time, much less three. Irrigation would require releases of water at times not optimum for power generation, and vice versa. Power generation is most efficient with a full reservoir, and flood control requires a lower level to receive surges from upstream.

There were also political purposes. "Egypt is the epitome of the downstream state."[2] The Nile, the world's longest river, flows 4,000 miles from its sources to the Mediterranean. Only the last 950 miles are within Egypt. Nine upstream states supply the Nile, several of them chronically unstable, presenting obstacles to a basin-wide agreement. It is noteworthy that Ethiopia provides 86 percent of the water that reaches Aswan. The High Dam allows Egypt to control storage, granted that part of the reservoir is in the Sudan and makes cooperation between the two states essential.

Another political purpose of the High Dam was fulfilled by the grandeur of the project. It is seventeen times the volume of the Great Pyramid. It would be a lasting monument to Nasser and Egypt's independence.[3] It was no wonder that Nasser decided that it would be built. Within four years, when the West reneged on promises of aid, Nasser seized the Suez Canal with the intent of using its revenues for the dam, fought a war, and turned to the Soviet Union for assistance.

In that context, discussions of possible negative effects had to be circumspect. One technician expressed the situation, quoting Omar Khayyam: "When the King says it is midnight at noon, the wise man says, 'Behold the moon.'"[4] Engineers asked questions concerning effects on stream flow, removal of the silt load and erosion of the channel, evaporation from the reservoir, sedimentation, degradation of the Delta coastline, induced seismic activity, and seepage, during the early planning. But since the government was committed to the dam, it became less receptive to these questions even though answers to them might have improved project design, and discussion was "suppressed."[5] Dr. Abd al-Aziz Ahmad, Chairman of the Hydroelectric Power Commission, criticized the project in British journals, citing the danger

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[2]John Waterbury, *Hydropolitics of the Nile Valley* (Syracuse, NY: Syracuse University Press, 1979), p. 5.
[3]Edward Goldsmith and Nicholas Hildyard, *The Social and Environmental Effects of Large Dams* (San Francisco: Sierra Club Books, 1984), p. 1.
[4]Waterbury, *op. cit.*, p. 101.
[5]Gilbert F. White, "The Environmental Effects of the High Dam at Aswan," *Environment*, 30, 7, September, 1988, pp. 4-11, 34-40, 8.

of excessive evaporation. Egyptian leaders thought he was offering ammunition to adversaries abroad, and he suffered professional ostracism.

If those who raised technical questions risked careers, those who warned of negative social or environmental consequences had more to fear. As Hussein Fahim put it,

> Government policy was not to be debated publicly before being formally adopted. Policies were to proceed from the top downward. The...public channels of technical and political dialogue were blocked....Anything that was described less than superlatively became potentially treasonous. As a result, the reasonably balanced combination of the political and the technical in the execution of big development schemes, designed to avoid the waste of scarce resources, was undermined....[T]he...following decade witnessed a total blackout of any [discussion of] mistakes or malfeasance connected with the Aswan High Dam.[6]

Foreign consultants also muted criticisms. An International Bank for Reconstruction and Development "review of its own involvement in the scheme revealed that the ecological ramifications of the dam...did not figure prominently in its own positive evaluation of the project."[7] Gilbert White termed the construction of the Aswan Dam "a massive, unique intervention in physical, biological, and human systems."[8] Such an intervention always has unintended consequences, foreseen or not.

The reservoir loses 20 percent of annual flow by evaporation and seepage. One effect of evaporation is to increase the salinity of the stored water; the salt content of the river entering Lake Nasser is 200 ppm, that of the water leaving it is 220 ppm.

The most serious ecological factor is that the sediment and nutrients carried by the river settle out in the reservoir at 130 million tons each year, and will fill it, perhaps, in five centuries. Windblown sand dunes spill into the reservoir, adding to fill and altering chemical composition.[9] Water leaving the dam is virtually free of suspended

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[6]Fahim, *op. cit.*, p. 165.
[7]Waterbury, *op. cit.*, p. 102.
[8]White, *op. cit.*, p. 38.
[9]M. El-Moattassem, "Field Studies and Analysis of the High Aswan Dam Reservoir," *International Water Power and Dam Construction*, 46, 1, January,

solids. Without silt, the erosive power of flowing water is greater. The river below the dam scours and lowers its bed, making it harder to get water into canals, and caving of banks sweeps away soil.

With elimination of sediment, the Delta loses land to coastal erosion. Shoreline retreats 30 meters a year. What ultimate good is a dam if Egypt loses a major part of the Delta, which contains 80 percent of Egypt's agricultural land? Sea water invades, further encroaching on farmland and wetlands inhabited by birds and other wildlife. The fish catch, once supported by Nile nutrients, has declined and many species have disappeared, although a growing catch from Lake Nasser is partial compensation. With silt gone, brickmakers began to strip topsoil.

A shift to perennial irrigation was a purpose of the High Dam. Basin irrigation was used throughout Egypt before the 19th century.[10] Earth banks divided the land into basins of from 1000 to 40,000 acres. Farmers allowed flood water into these and held it there 40 to 60 days, during which it dropped its silt, forming a flat surface. Perennial irrigation, universal today, runs water through canals onto the land every two or three weeks throughout the year. Without adequate drainage, it waterlogs the soil. Planners abandoned a 1958 project to install field drains because they thought a lower Nile would improve drainage. The opposite happened. The water table rose from 15 meters below surface to three meters. In Cairo, the water table is only 81 centimeters below the surface. Ninety percent of cultivated land in Egypt is waterlogged, and 35 percent is salinized. When water evaporates from soil without adequate drainage, salts accumulate at as much as a ton per hectare per year.[11]

Since perennial irrigation provides no nutrients, fertilizer is applied, and the rate has increased exponentially. A fertilizer factory uses much of the power from the dam. Fertilizers and pesticides pollute drainage, yet that is what Egypt plans to pump to new croplands.

Fertilizers in water cause algal growth. Stimulated by sunlight penetrating the clearer water, it multiplies enormously and has clogged Cairo's purification system. Water hyacinths cover 82 percent of water

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1994; Daniel Jean Stanley and Jonathan G. Wingerath, "Nile Sediment Dispersal Altered by the Aswan High Dam: The Kaolinite Trace," *Marine Geology*, 133, 1/2, July, 1996.

[10]H.E. Hurst, *The Nile: A General Account of the River and the Utilization of Its Waters* (London: Constable, 1957), pp. 38-41.

[11]Fred Pearce, "High and Dry in Aswan," *New Scientist*, 142, 1924, May 7, 1994, p. 30.

courses, and their transpiration increases annual evaporation perilously. Massive herbicide applications destroy non-target plants and animals.

Predicted was an increase in schistosomiasis, caused by parasitic worms that pass into water in urine and feces and infect snails as alternate hosts. The debilitating disease can lead to death. Since the dam, urinary schistosomiasis, previously more common, has decreased due to public health measures. But the intestinal form has spread. Perennial irrigation keeps farmers in contact with water through the year and gives snails a permanent habitat.[12] Malaria has become more of a problem in Nubia and the Sudan with the increase in slack water.

The reservoir displaced more than 110,000 Nubians, whose villages and land were sacrificed for the prosperity of more numerous people downstream. The Egyptian government resettled many in "New Nubia," north of Aswan, providing education, health care, and land, requiring them to raise sugar cane, an unfamiliar crop. For Nubians, it was an alien environment too far from the Nile. Sudan moved its Nubians to settlements near Khashm el Girba. They received community services and leased land, and were directed to raise cotton and peanuts. Herding nomads who already used the land resented the intrusion. Many Nubians avoided resettlement areas, seeking city jobs. Others refused to leave Nubia, or returned, where some farm or provide tourist services.

A purpose of the High Dam was to open new areas for cultivation. By 1982, work had begun on almost one million acres, but irrigation reached less than 20 percent. Total acreage declined due to urbanization, brickmaking, waterlogging, and salinization, but productivity increased due to the shift of 900,000 acres to multiple cropping.

Predictions for reclaimed land are optimistic because they assume fertility equal to old lands, but soil is a living ecological community, not just a substrate. Heavy desert soils will not produce without expense of energy, materials, and time. Soils in new lands are poor and unsuited to export crops. Egypt proceeds with projects to reclaim the desert, but water may prove inadequate in quantity and/or quality.

Could the planners who considered building the High Dam have avoided some of the worst mistakes? The modern environmental history of Egypt, including the first Aswan Dam and its heightenings, could have provided warnings that might have helped prevent some of

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[12]Fahim, *op. cit.*, p. 34.

the damaging effects of the High Dam, or led to a decision not to build it.

The transformation of Egypt from a society dependent on traditional agriculture to an adjunct of the world market economy began with Mohammed Ali, who ruled Egypt from 1811 to 1847. To enrich himself through commerce, he began cotton cultivation in the Delta. Primarily for export, cotton as a second crop required irrigation when the Nile was low. He envisioned a double barrage where the Rosetta and Damietta branches of the Nile diverge north of Cairo to divert the flow into canals. He was barely persuaded not to use stones from the pyramids to build it.[13] Construction was finished in 1861. The venture prospered when the American Civil War deprived world markets of the largest source of cotton.

The British, who seized control in 1882, forwarded the agricultural revolution for their own benefit. Lord Cromer brought in engineers to repair the irrigation infrastructure. They noted the problems of waterlogging and salinization. In 1894, Sir William Willcocks proposed a dam at Aswan to create a reservoir holding 2.4 billion cubic meters of water. He remarked, "It will be an evil day for Egypt if she forgets that...the lessons which basin irrigation has taught for 7,000 years cannot be unlearned with impunity. The rich muddy water of the Nile flood has been the mainstay of Egypt...and it can no more be dispensed with today than it could in the past."[14] He knew silt would clog his reservoir unless he could let through the first part of the annual flood, containing almost all the sediment. The dam could hold the last portion of the flood because the water then was relatively clear. He planned 180 sluices with gates designed to let the flood pass.

The project waited four years while Cromer looked for funding. Sir Ernest Cassel, a multi-millionaire friend of Edward VII whose company had Egyptian land investments, offered a loan. Meanwhile, another issue agitated the world of arts and letters: the dam would flood the temples of Philae, graceful buildings surviving from antiquity. The cost of moving the temples was prohibitive.[15] Philae should be sacrificed "to the welfare of the world," said a young officer on a Sudan

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[13]Hurst, *op. cit.*, p. 50.

[14]Willcocks, 1908, quoted in Waterbury, *op. cit.*, p. 39.

[15]They were moved at the time the Aswan High Dam was constructed, as part of the UNESCO project to save the monuments of Nubia.

expedition, Winston Churchill.[16] Little concern was voiced for Nubian villagers whose lands and homes would also be flooded. Sir Benjamin Baker, consulting engineer, scaled down Willcocks' dam by 20 feet to protect Philae, though water entered the temples when the reservoir filled. This lowering reduced volume to one billion cubic meters. Construction lasted from 1898 to 1902. The dam was 6,400 feet long and 66 feet high.

Soon the managers discovered that the low dam did not retain enough water to supply its backers, particularly Cassel and his desert irrigation project. By 1912 the dam was raised 23 feet, to 89 feet, the capacity Willcocks sought originally.[17]

Demand for irrigation continued to grow, and since the Nile must be shared with Sudan, a second heightening was proposed to store more of Egypt's water. By 1933 the dam was raised again, this time by 30 feet, to 118 feet. Capacity more than doubled, to over five billion cubic meters.

The old Aswan Dam, with its two heightenings, produced many, but not all, of the side effects that later appeared with the High Dam. There was downstream scouring and lowering of the river bed. The dam flooded part of Lower Nubia every year, displacing more Nubians with each raising of the structure. These people relocated themselves to villages north of Aswan, or to Cairo, receiving small compensation.

Environmental problems, such as inadequate drainage, water-logging, and salinity, worsened after 1902. In some areas, the schistosomiasis rate rose from 21 percent to 75 percent.[18] The need to address the drainage problem was clear. Retreat of the coastline at the outlets of the Nile and invasion of the Delta by sea water were observed after the 1933 heightening. Works to counter coastal erosion began, but proved ineffective.

Thus the environmental effects of the High Dam were not entirely hypothetical at the time of the decision to build it. Historical precedents were available from a dam on almost the same site. But in authorizing the High Dam, the negative effects of the older dam were not seriously

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[16]Herbert Addison, *Sun and Shadow at Aswan: A Commentary on Dams and Reservoirs on the Nile at Aswan: Yesterday, Today, and Perhaps Tomorrow* (London: Chapman and Hall, 1959), p. 43.
[17]Peter Mansfield, *The British in Egypt* (London: Weidenfeld and Nicolson, 1971), p. 118.
[18]J.N. Lanoix, "Relation Between Irrigation Engineering and Bilharziasis," *Bulletin of the World Health Organization,* 18, 1958.

considered, since those who could have commissioned studies were already committed to the project. Waterbury observed, "The history of this project is testimony to the primacy of political considerations determining virtually all technological choices with the predictable result that a host of unanticipated technological and ecological crises have emerged that now entail more political decisions." He terms Egypt's policies leading to the dam "short-sighted" and "non-integrated."[19]

The antidote for short-sightedness is careful consideration of environmental history and the need for sustainability. The antidote for a non-integrated approach is consideration of the many facets of the ecosystem, since massive actions always have unintended effects, and humans cannot exceed the limits of the ecosystem without catastrophic results.

Two problems lessen the possibility that Egypt can arrive at a sustainable level of production within the limits set by water, land, and the Nile Valley ecosystem. First is population. At the time the first Dam was under construction, Egypt had 10 million people. With the High dam rising, the population passed 30 million. In 1995 it was 63 million, heading toward 97 million in 2025. This pattern indicates expanding demand for water. Where will it come from?

Second is urbanization. Every year a larger percentage of Egyptians live in cities, particularly Cairo, which had 7.5 million people in 1976, and reached 17.3 million in 2000, 25 percent of Egypt's population. Industrial, commercial, and residential buildings, with infrastructure, use space and water, in spite of a 1984 law prohibiting urban development on agricultural land. Estimates indicate a water deficit for Egypt of 14 billion cubic meters by 2025.

The Nile will not grow, but upstream projects might send more water to Egypt. Most ambitious is the partially constructed Jonglei canal in southern Sudan, intended to carry water past the Sudd swamps and end the evaporative loss of half the flow of the White Nile, but now halted by war.[20] By drying up a huge wetland, Jonglei would damage an ecosystem and decimate wildlife. Sudan has treaty rights to half the additional Jonglei water. What of the other upstream states? Ethiopia's population, growing at twice the rate, will soon surpass Egypt's, and could reach 127 million in 2025. Ethiopia wants irrigation projects

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[19]Waterbury, *op. cit.*, pp. 5-6.

[20]Robert O. Collins, *The Waters of the Nile: Hydropolitics and the Jonglei Canal, 1900-1988* (Oxford: Clarendon Press, 1990), p. 272.

using the headwaters. Nasser, Sadat, and Mubarrak each threatened war with any state that takes "Egypt's water."[21] Sooner or later a plan for the watershed must be negotiated. But no plan can meet the desires of every nation concerned to support its growing population and to achieve economic growth by producing more for world markets.

As far as the decision to build the Aswan High Dam is concerned, if the experience of the past had lessons to teach, they seem not to have been learned. The present ecological situation of Egypt is precarious. It is difficult to imagine what the path to sustainability might be, since the constraints of politics convince planners, and they rarely consider the limits of the ecosystem. But planning will be misleading until it takes account of the ecological-historical perspective.

[21]Fahim, *op. cit.*, p. 160.