# Egypt's Nile Valley Basin Irrigation

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## (excerpted from Pillar of Sand)

In striking contrast to the early Indus civilization and those of Sumer, Akkad, Babylonia, and Assyria in Mesopotamia, the great Egyptian civilization in the Nile River valley has sustained itself for some 5,000 years without interruption. It lasted through warfare and conquest by the Persians, Greeks, Romans, Arabs, and Turks, as well as through pandemic disease that devastated its population. Yet its agricultural foundation remained intact. Only in more recent times has the sustainabililty of Egyptian agriculture come into question. In response to a 20-fold increase in its population over the last two centuries-from 3 million in the early 1800s to 66 million today-Egypt replaced its time-tested agriculture based on the Nile's natural flow rhythms with more intensified irrigation and flood management that required complete control of the river.[1]

Compared with the flashy floods of the Tigris and the Euphrates, the historic Nile flood was much more benign, predictable, and timely. As is the case today, most of its flow originated from monsoon-type rains in the Ethiopian highlands. The remainder came from the upper watershed of the White Nile around Lake Victoria. With almost calendrical precision, the river began to rise in southern Egypt in early July, and it reached flood stage in the vicinity of Aswan by mid-August. The flood then surged northward, getting to the northern end of the valley about four to six week later.

At its peak, the flood would cover the entire floodplain to a depth of 1.5 meters. The waters would begin to recede in the south by early October, and by late November most of the valley was drained dry. Egyptian farmers then had before them well-watered fields that had been naturally fertilized by the rich silt carried down from Ethiopia's highlands and deposited on the floodplain as the water spread over it. They planted wheat and other crops just as the mild winter was beginning, and harvested them in mid-April to early May. By this time, the river's flow had diminished, sustained only by the more constant flow of the White Nile; the floodplain was completely dry. Then, magically to the ancients, the cycle started all over again. Even into modern times, every June 17$^{th}$ Egyptians celebrated the "'Night of the Drop,' when the celestial tear fell and caused the Nile to rise."[2]

The Egyptians practiced a form of water management called basin irrigation, a productive adaptation of the natural rise and fall of the river. They constructed a network of earthen banks, some parallel to the river and some perpendicular to it, that formed basins of various sizes. Regulated sluices would direct floodwater into a basin, where it would sit for a month or so until the soil was saturated. Then the remaining water would be drained off to a basin down-gradient or to a nearby canal, and the farmers of the drained plot would plant their crops.[3]

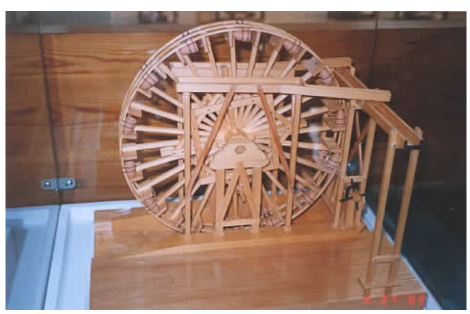
The earliest evidence of water control in ancient Egypt is the famous historical relief of the mace head of Scorpion King which dates to around 3,100 BC. It depicts one of the last predynastic kings, holding a hoe and ceremoniously cutting a ditch in a grid network. Besides attesting to the importance of these waterworks and the great ceremony attached to them, this picture confirms that Egyptians began practicing some form of water management for agriculture about 5,000 years ago.[4]

Egyptian irrigators did not experience many of the vexing problems that plagued (other historic) irrigation societies. The single season of planting did not overly deplete the soil, and fertility was naturally restored each year by the return of the silt-laden floodwaters. In some basins, farmers planted grains and nitrogen-fixing legumes in alternative years, which helped maintain the soil's productivity. Fallowing land every other year, which was essential in (areas like) Mesopotamia, was thus unnecessary in the Nile valley.[5]

Neither was salinization a problem. The summer water table remained at least 3-4 meters below the surface in most basins, and the month or so of inundation prior to planting pushed whatever salts had accumulated in the upper soil layers down below the root zone. With salt buildup naturally checked and fertility constantly restored, Egyptian agriculturists enjoyed not only a productive system, but a sustainable one.

For nearly 1,500 years Egyptian farmers cultivated about 800,000 hectares under this system of basin irrigation. The *shaduf*, the water-lifting device already in use in Mesopotamia appeared in upper Egypt sometime after 1500 BC (see Illustration 1). This technology enabled farmers to irrigate crops near the river banks and canals during the dry summer. This would have allowed the cultivated area to expand by 10-15 percent. A similar increase might have been afforded by the waterwheel, introduced sometime after 325 BC (see Photograph 1). So by the time Egypt had become a breadbasket for the Roman Empire, some 1 million hectares of land were effectively under cultivation in the course of a year.[6]

*Illustration 1. A shaduf was used to raise water above the level of the Nile.*



*Photograph 1. A noria, buckets attached to a waterwheel, was another device used to lift water.*

The blessings of the Nile were many, but they did not come without some costs. A low flood could lead to famine, and too high a flood could destroy dikes and other irrigation works. Even a 2-meter drop in the river's flood level could leave as much as a third of the floodplain unwatered.[7]

The well-known biblical account of Joseph and the Pharaoh's dream is a reasonable reflection of the threat of famine that Egyptians periodically faced. Asked to interpret his ruler's dream, Joseph foretells several years of abundant harvests followed by seven years of shortage, and advises the Pharaoh to begin storing massive quantities of grain to avert famine. During a period of disappointing floods between the reigns of Ramses III and Ramses VII in the twelfth century BC, food shortages caused the price of wheat to rise markedly. Prices stabilized at a high level until the reign of Ramses X, and then fell rapidly as shortages eased by the end of the Ramessid Dynasty, about 1070 BC.[8]

Because of the link between the Nile's flow level and Egyptian well-being, early on the ancient Egyptians developed a system for measuring the height of the Nile in various parts of the country. This monitoring allowed them to compare daily river levels with years past and to predict with some accuracy the coming year's high mark. At least 20 "nilometers" were spaced along the river, and the maximum level of each year's flood was recorded in the palace and temple archives (see Photograph 2).[9]

*Photograph 2. The nilometer on Elephantine Island, Aswan, consists of stairs and staff gauges.*

In combination, the reliability of the Nile flood and the unpredictability of its magnitude rooted ancient Egyptians deeply in nature and fostered respect for order and stability. Rulers were viewed as interveners with the gods to help ensure prosperity. Father of all gods was the god of the Nile-Hapi-who although male was portrayed with breasts to show his capacity to nurture.[10]

The Egyptians worshipped Hapi not only in temples, but through hymns:

> Praise to you, O Nile, that issues from the Earth, and comes to nourish Egypt . . .
>
> If his flood is low, breath fails, and all people are impoverished; the offerings to the gods are diminished, and millions of people perish. The whole land is in terror . . .
>
> When he rises, the land is in exultation and everybody is in joy . . .
>
> He fills the storehouses, and makes wide the granaries; he gives things to the poor.[11]

In contrast to (other historic) civilizations, early Egyptian society did not centrally manage state irrigation works. Basin irrigation was carried out on a local rather than a national scale. Despite the existence of many civil and criminal codes in ancient Egypt, no evidence exists of written water law. Apparently, water management was neither complex nor contentious, and oral tradition of common law withstood the test of a considerable amount of time.

Although difficult to prove, the local nature of water management, in which decisionmaking and responsibility lay close to the farmers, was probably a key institutional factor in the overall sustainability of Egyptian basin irrigation. The many political disruptions at the state level, which included numerous conquests, did not greatly affect the system's operation or maintenance. While both slaves and *corvee* labor were used, the system's construction and maintenance did not require the vast numbers of laborers that Mesopotamia's irrigation networks demanded. The waves of plague and warfare that periodically decimated Egypt's population did not result in the irrigation base falling into serious disrepair, as occurred in (other historic systems).

Local temples appear to have played an important role in redistributing grain supplies to help cope with the periodic famines. From very early times, boats plied the Nile and were used to transport grain from one district to another. The surplus from several districts might be stored in a central granary and shared to secure food supplies for the whole region. Fekri Hassan, a professor in the department of Egyptology at the University of London, speculates that the emergence of kingship in Egypt was linked to the need for larger coordination in collecting grain and providing relief supplies to districts experiencing crop failure.[12]

The central government imposed a tax on the peasant farmers of about 10-20 percent of their harvest, but the basic administration of the agricultural system remained local. As Hassam observes, "Egypt probably survived for so long because production did not depend on a centralized state. The collapse of government or the turnover of dynasties did little to undermine irrigation and agricultural production on the local level."[13]

Overall, Egypt's system of basin irrigation proved inherently more stable from an ecological, political, social, and institutional perspective than that of any other irrigation-based society in human history. Fundamentally, the system was an enhancement of the natural hydrological patterns of the Nile River, not a wholesale transformation of them. Although it was not able to guard against large losses of human life from famine when the

Nile flood failed, the system sustained an advanced civilization through numerous political upheavals and other destabilizing events over some 5,000 years. No other place on Earth has been in continuous cultivation for so long.

*Source*: Postel, Sandra, 1999. *Pillar of Sand: Can the Irrigation Miracle Last?*, W.W. Norton Company (A Worldwatch Book), New York. www.worldwatch.org

## Notes

1. Early 1800s population from: Malcom Newson, *Land, Water, and Development: River Basin Systems and Their Sustainable Management* (London: Routledge, 1992); current population from Population Reference Bureau, *World Population Data Sheet*, wallchart (Washington DC: 1998).
2. Karl W. Butzer, *Early Hydraulic Civilization in Egypt: A Study in Cultural Ecology* (Chicago: The University of Chicago Press, 1976); quote from M.S. Drowser, "Water-Supply, Irrigation, and Agriculture," in C. Singer, E.J. Holmyard, and A.R. Hall, eds., *A History of Technology* (New York: Oxford University Press, 1954).
3. Drowser, ibid.
4. Butzer, op.cit. reference [2]
5. Ibid
6. Ibid
7. Ibid
8. Gen. 41:1-37 (Revised Standard Version of the Bible); J. Donald Hughes, "Sustainable Agriculture in Ancient Egypt," *Agriculture History*, Vol. 66, pp. 12-22 (1992); Butzer, op. cit. reference 2.
9. Drowser, op. cit. reference 2.
10. Fekri A. Hassan, "The Dynamics of a Riverine Civilization: A Geoarchaelogical Perspective on the Nile Valley, Egypt," World Archeology, vol. 29, no. 1 (1997).
11. Selected portion of the hymn as quoted in Hughes, op. cit. reference 8.
12. Hassan op. cit. reference 10.
13. Tax figures from Will Durant, *Our Oriental Heritage* (New York: Simon and Schuster, 1954); Hassan, op. cit. reference 10.

Upper Egypt refers to southern Egypt, specifically to the Nile Valley south of Cairo. Lower Egypt refers to northern Egypt, usually the Nile Delta, north of Cairo. The regions are so named because Upper Egypt is along the upriver section of the Nile and Lower Egypt is located on the down river section of the Nile. The Nile Valley is 930 miles (1510 kilometers) long and varies in width from two to 10 miles (three to 16 kilometers). Stretching the length of Egypt from north to south and occupying a depression around the Nile River, it occupies 3 percent of Egypt's land but is home to 96 per Egypt has the largest irrigation area among Nile Basin countries. The total area equipped for irrigation in Egypt is estimated at 3.45 million hectares (3.4% of the total area of the country) and a cropped area estimated at about 5 million hectares. 85% of this is in the Nile Valley and Delta. The estimated cropping intensity is 146%. The irrigation system in the old land of the Nile Valley is a combined gravity and water lifting system (lift: about 0.5-1.5 m). Most of the water used in irrigation in Egypt is surface water with some water taken from groundwater sources. various irrigation goals of the Nile basin nations. Adding to. potential water stress, many large hydropower dams are being.Â  bands of the Nile Valley and the narrow coastal strip, where some 150-mm of winter rain falls. All this.Â  agricultural sector could reduce the water flow to Egypt significantly. The Nile River is the principal source.