The Nilometer in Cairo

The Nilometer in Cairo, on the southern tip of Roda Island, is a unique historical site which is often overlooked by visitors. It is one of the oldest existent structures which dates back to the period just after the Arab conquest of Egypt. Nilometers, known as al-Miqyas in Arabic, were used to measure the levels of the Nile River and are a remarkable reminder of Egypt's illustrious past. These water measurement structures continued to be useful up until the modern era when the Nile's natural flows were disrupted by large water storage reservoirs. Since the Nile River has been of critical economic importance to both ancient and modern civilizations alike, officials have gauged its water levels for more than 5,000 years, writing them down for more than 13 centuries. The Nilometer is an excellent example of an historic water measurement device.

History

Although a Nilometer has existed in the Cairo area since the Pharaonic Period, the Umayyads (an early Arab dynasty) constructed a Nilometer on Roda Island in about 715 AD. This structure was restored in 815, but was destroyed by a flood in 850. The Nilometer existent on Roda Island today was designed by Abu'l 'Abbas Ahmad ibn Muhammad ibn Kathir al-Farqhani, a native of Farghana, West Turkestan, who is known in the West as the astronomer Alfraganus. The structure was restored in the 870's and again in 1092. It remains mostly original, except for the wooden conical roof (domed on the inside) which is a modern restoration (see Photograph 1). The earlier dome was destroyed by an explosion during the French occupation in 1825. It was rebuilt using, as a reference, an 18th century drawing by a Danish traveler (see Photograph 2).

Photograph 1. Exterior of the Nilometer on Roda Island.

Photograph 2. Interior of the Nilometer (Photographed by Bill Hocker).

The Cairo Nilometer is a more sophisticated instrument than earlier pharaonic and roman examples such as the one on Elephantine Island at Aswan (see Photograph 3). The Cairo model consists of a large pit (or stilling well) that extends below the level of the Nile. The stilling well is connected to the Nile by three tunnels (each at different elevations) on the structure's eastern side (see Photograph 4). These tunnels are now blocked off from the Nile River, so that the Nilometer is no longer functional. There are 45 steps leading down to the bottom of the stilling well. The height of each step is 24 cm. The steps allowed for a quick reading of the Nile River's water level.

Photograph 3. The Nilometer on Elephantine Island, Aswan, consists of a flight of stairs and staff gauges.

Photograph 4. The Nilometer on Roda Island is connected to Nile River by three tunnels, one of which is shown here.

In the center of the large well is a marble octagonal column was a Corinthian capital. The top of the column is held in place by a wooden beam spanning the Nilometer. To measure the water level, the column is graded and divided into 19 cubits (a cubit equals approximately half a meter), and thus can measure water levels up to about 9.5 meters. The floods measured by this Nilometer were important to both the rulers of Egypt, the Caliph, and the general population. During the summer months, the Cairo Nilometer was used to regulate the distribution of water as well as to compute the levy of taxes paid as tribute by Egypt to the Arab Caliph. An ideal flood filled the Nilometer to the 16 cubit mark; less could mean drought or famine (see Figure 1) and more could mean a catastrophic flood.

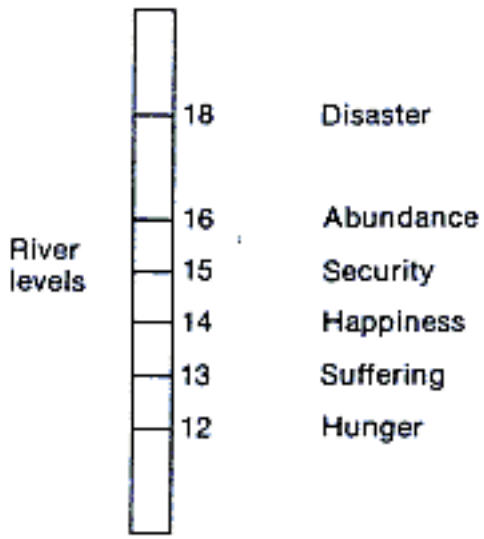

Figure 1. Real-world interpretation of the readings from the Nilometer.

Because of its importance in determining the area's prosperity, the Cairo Nilometer was important trigger for the medieval celebration of Fath al-Khalij, the festival of the Opening of the Canal. The Khalij Canal originated opposite Roda Island and was blocked with an earth dam. It would be opened when the water level in the Nile River reached 16 cubits. At this level, the summer flood from the river was used to fill the canal. During the celebrations, decorated boats would crowd the river. Those who witnessed it referred to it as Cairo's most spectacular festival. Near the Nilometer was a mosque for prayers. The grand celebration was not a guaranteed annual event. Years when the Nile flood water failed to reach 16 cubits, the celebrations were canceled, and prayers and fasting were held instead.

Historical Record

The Nilometer at Roda Island provides an important long-term record of the water levels in the Nile River. In 1936, Jarvis speculated: "In spite of all the changing, uncertain, and erroneous factors that must be considered in connection with records of stages of the Nile River, it is believed that they disclose some important information; and there is a fair prospect that they may yield more data with further study . . ." This statement turned out to be very prophetic. Data collected from the Nile River have spurred the development of a whole field of mathematics (fractional Brownian motion and fractional Gaussian noise) along with a field of statistics concerned with the behavior of long memory time series. Gathered by Toussoun (1925), there exists a remarkable hydrological time series of minimum and maximum water levels for the Nile River. Starting in 622 AD and ending in 1922 AD, the first missing observation in the annual minima occurs in 1285. This leaves several continuous records to analyze, the longest one (662 years) is shown in Figure 2.

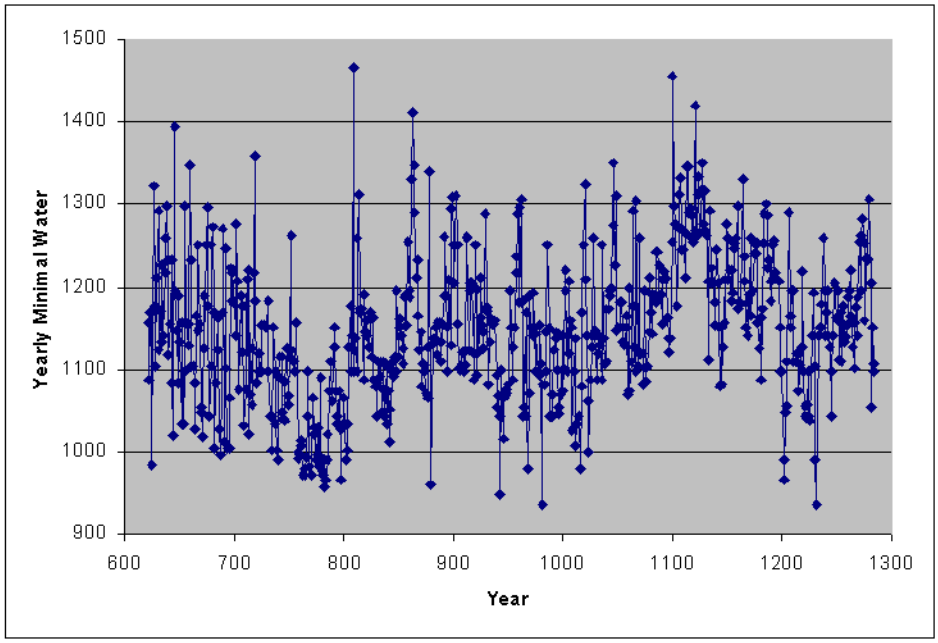

Figure 2. Time-series record of the Nile River minimum water levels from 662-1284 AD

In an interesting historical note, Whitcher et al (2002) studied the statistical properties of the long-term Nile River levels from 622 to 1284 AD. Their test confirm an inhomogeneity of the variance and identify the change point at around 720 AD. This date coincides with the construction of the "new" Nilometer on Roda Island.

One way to anticipate future climate changes is to understand the past. But good instrumental records of such things as temperature and precipitation extend back only 150 years. This time series is too short to gain a complete understanding of how climate systems vary. With an eye toward extending the history of climate further back in time, recent studies have employed various types of data as "proxies" for climate indices. These in turn can be related to other large-scale phenomena such as El Nino frequency.

Eltahir and Wang (1999) studied the historic water levels from the Nile River (at Cairo) extending back to 622 AD. The researchers found a strong relationship between the Nile's water level and the existence of El Nino-so strong, in fact, that the Nile record can be used as a proxy for El Nino occurrence. Using this proxy, they reconstructed the history of El Nino for the past 1,300 years. They found that the frequency of El Ninos in the 1990s has been greatly exceeded in the past. In fact, the period from 700 to 1000 AD was a very active time for El Ninos, making our most recent decade or two of high El Nino frequency look comparatively mild.

Traveler Information

I (Roger Hansen) visited the Nilometer in December 2003 (see Figure 3 for a location map). I was the first to visit on that particular day and the facilities had not yet been opened. The cost of admission was 6 pounds E and the caretaker was very pleasant and accommodating.

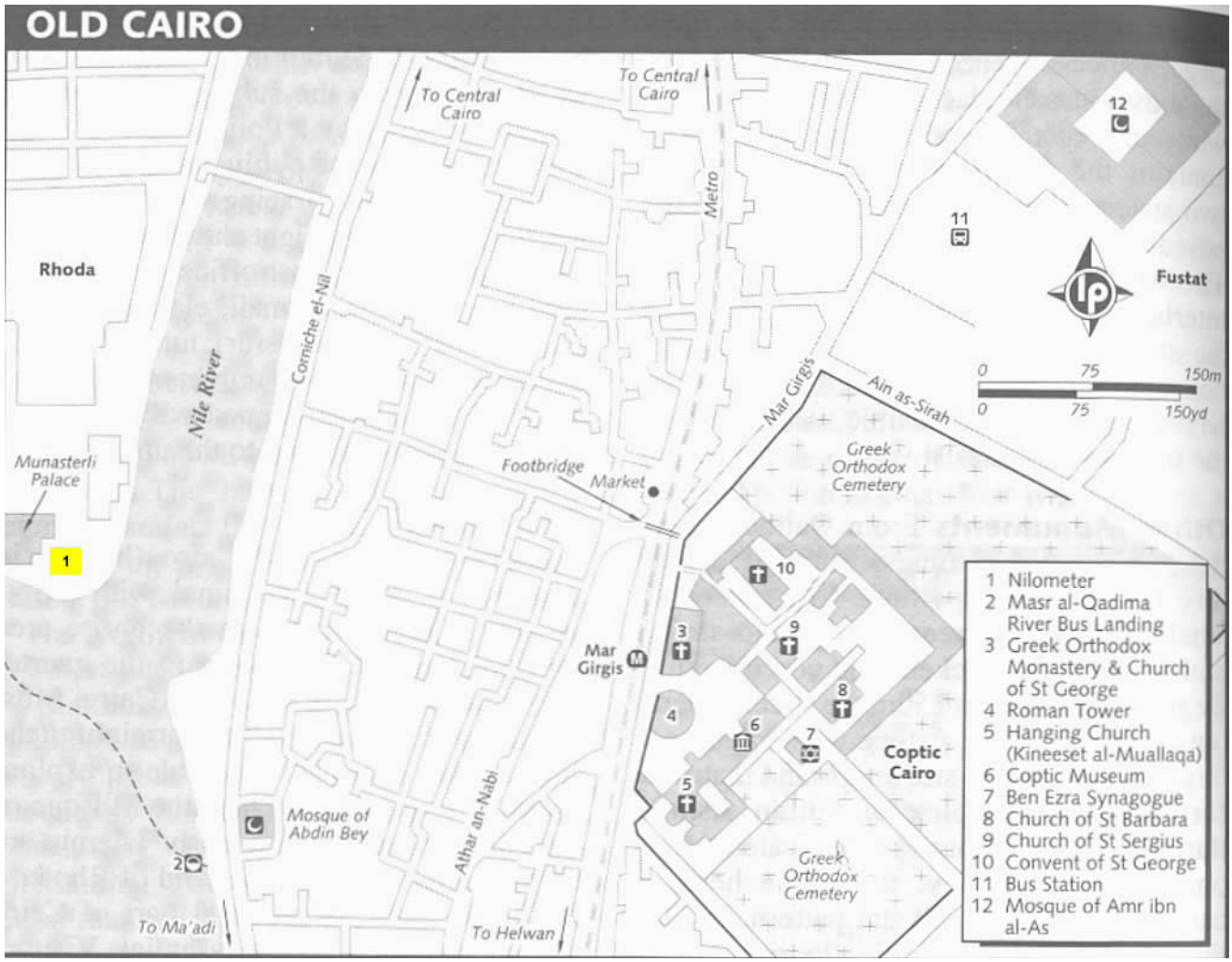

Figure 3. Map showing general location of the Nilometer

Inside, the Nilometer is much more stunning than I had anticipated (see Photograph 2 above). The caretaker opened a gate so I could descend to the bottom of the stilling well. The Cairo Nilometer setup anticipates a modern water measurement structure with its stilling well, connection(s) to the river, enclosure, and staff gauge. All that is missing is some sort of mechanical continuous recording device (like a strip chart). A visit to the Nilometer on Roda Island is highly recommended.

From downtown Cairo, the easiest way to get to the Nilometer is by taxi.

References

Abaza, I. (undated), "The Nilometer on Rawda (Roda) Island in Cairo" www.touregypt.net/featurestories/nilometerroda.htm

Eltahir, E.A.B. and G. Wang, 1999. "Nilometers, El Nino, and Climate Variability," *Geophysical Research Letters*, 26, 489-492.

Jarvis, C., 1936. "Flood-Stage Records of the River Nile," *Transactions of the American Society of Civil Engineers* 101, 1012-1071.

Toussoun, O., 1925. "Memoire sur l'Histoire du Nil." In *Memoires a l'Institut d'Egypte*, Volume 18, pp. 366-404.

Whitcher, B., S. Byers, P. Guttorp, and D. Percival, 2002. "Testing for Homogeneity of Variance in Time Series: Long Memory, Wavelets and the Nile River" *Water Resources Research*, 38 (5).