Protecting the Nile Delta from rising sea levels

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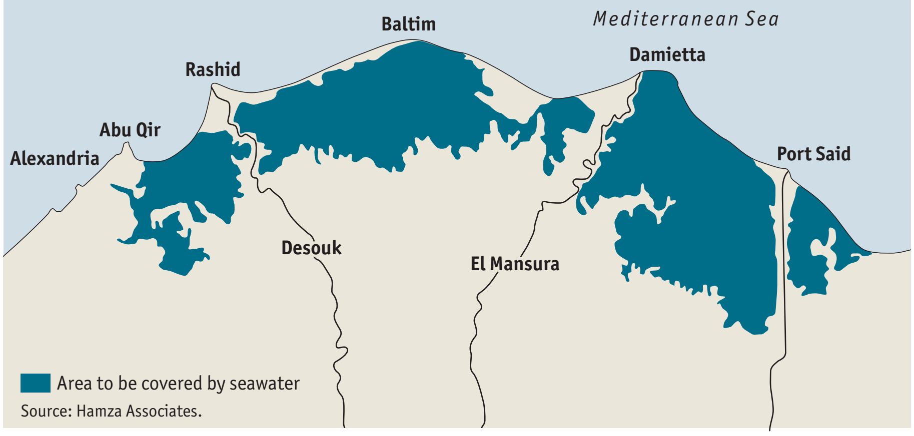
In June 2007, the Egyptian cabinet's Support Centre for Decision Making issued an alarming report. It predicted a nearly 1-metre rise in the level of the Mediterranean Sea, which extends about 1,000 km along Egypt's north coast, as a result of global warming. The water is expected to rise incrementally: around 23 cm by 2020 and 40 cm by 2050, with a full metre rise expected by the end of this century. The seawater level is estimated to have risen by about 20 cm during the 20th century.

Many scientists and engineers in Egypt, including me, were gravely concerned by this report. Using a conservative assumption that the current seawater level has a local elevation of ± 0 metres, it is simple to designate which low lying parts of the Egyptian Delta would be under water should the 1-metre rise occur. Since the current seawater elevation along the Egyptian coast actually averages not ± 0 metres but between +0.3 to +0.5 metres, it is a very conservative assumption indeed. A 1-metre rise of seawater above the actual elevation would result in a larger flood zone in the Delta—Egypt's main farm belt—than the figures given here.

Affected area of the Nile Delta



Source: Hamza Associates.

Using military maps, topographic maps, satellite images and the above conservative assumption, the minimum land area that would be affected by the 1-metre rise in seawater is around 622,715 ha (6,070 sq km). Bordering the submerged area would be a buffer area, created by seawater fluctuation and evaporation, with a high percentage of groundwater salinity and a surface

* The following article has been written for the Economist Intelligence Unit by Mamdouh Hamza, the chairman of Hamza Associates, a Cairo-based consulting engineering firm whose work has included a number of major marine and hydraulic projects in Egypt and elsewhere in the region. The article assesses the nature of the threat posed by global warming to the low-lying Nile Delta, and outlines a proposal for confronting that threat. The views expressed in the article are the author's own.

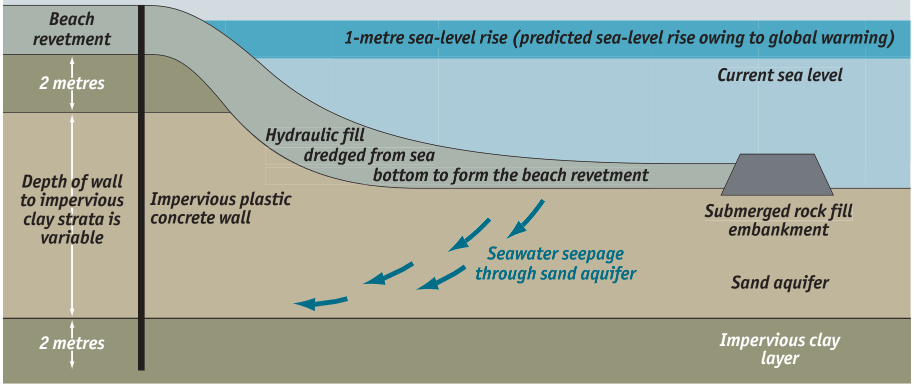
covered by salt. This buffer area adds another 60,700 ha to the expected loss of agricultural land. Site visits to Rosetta, 1 km from the shoreline, have indicated, beyond doubt, that the very salty buffer area is already developing and will continue to move in line with the rise in sea level.

Agricultural land will not be the only loss. Roads, railways, schools, hospitals, post offices, clinics, government-owned and private buildings, banks, and factories will be damaged beyond use. Especially devastating will be the loss of housing, particularly in the heavily populated rural and urban areas with a high concentration of the very poor, and of several hundred thousand jobs. There is no accurate figure for the population that would be displaced. If the sea-level rise occurred today, an estimated 3.5m inhabitants would become "climate refugees", unless the government of Egypt takes action to protect the Delta. By the end of this century, the number of such refugees could be ten times higher.

The Delta currently faces two unfavorable conditions: first, it has a subsidence rate of about 1.6 mm/year because of the nature of its disposition geologically; second, the coast is experiencing accelerated erosion from the West-East coastal current, which is no longer balanced by flood sediments that stopped after the building of the Aswan High Dam. Thus, the effects of the sea-rise will be more severe on the already ailing Nile Delta.

In October 2007, a few months after the government's warning, this writer announced a schematic design for a project that would protect the Delta from the sea-rise at the surface level as well as the infiltration of seawater into the sand aquifer. There are three main components to the scheme, which addresses only the 300 km of the Nile Delta coast.

Schematic design for delta protection



The first component is to raise the level of the coastal land areas to be adequately higher than the predicted sea-level rise and associated waves. It is proposed that the beach-nourishment technique that is routinely used for creating or improving the status of a beach should be employed. In this case, however, the technique would be used to construct a beach revetment along Egypt's entire 300-km Delta coast, using sand from the sea bottom as hydraulic fill. The height of the revetment would be dictated by the predicted rise in seawater. The method will assure that the beaches remain sandy and useable, as intended, but at a higher level to protect against the rising seawater. To reduce the amount of sand required, and to prevent its slipping downward and back to the sea, an underwater rock fill embankment would be constructed at a distance of, say, 60 metres from the shoreline. Other measures will also be required to protect the sand from erosion caused by the west-east coastal currents, and using spearheads perpendicular to the beach should be considered.

The second component of the scheme is to protect against the potentially catastrophic increase in salinity from the seepage of seawater through the sand revetment or the sand aquifer below the surface of the ground. A thin, underground impervious wall, the most costly component of the protection scheme, would be constructed starting from the crest of the revetment and embedded in the clay strata below the sand at varying depth. The wall would be constructed by introducing a slot parallel to the northern coastline of about 300 km with a thickness of 60-80 cm and an average depth of about 25 metres. The slot will be filled with plastic concrete, with a major inclusion of bentonite, which would provide a highly impervious material that creates a "dam effect".

Constructing regulated structures at the entrances of the Nile River branches and the northern lakes, such as Manzala, Borollous, Mariout, and Edko, is the third component of the protection scheme, and the most technically difficult to design and construct. The structures will follow the concept of the gates built to protect Venice.

The proposed scheme involves no new techniques or technologies and will use locally available materials and equipment. At current prices, the cost of construction would be in the range of €5bn (US$7.5bn), a staggering figure for Egypt; the time needed to construct the protective system would be between eight and ten years, which is not a problem, if started in the next couple of years. This cost is in addition to that required to raise the embankment along the 160-km length of the Suez Canal—another necessity owing to the effects of global warming. The question now is who should pay the price—the victims or those who induced the suffering?

