Confronting sea level rise

on Egypt's Nile Delta coast

The fertility of Egypt's Nile Delta is of historic significance. Intensive agriculture in the region dates back 5,000 to 6,000 years. Today, nearly half of Egypt's population lives in the Delta, and the region accounts for some 40% of the country's agricultural production.

By the numbers

19.4 million* people live in the Coastal Nile Delta area

40 percent of Egyptian agricultural products come from the Delta

60 percent of the study area will be affected by saline groundwaters and rising water tables by 2100

** Estimated 2010 population of six coastal governorates: Alexandria, Beheira, Kafr-el-Sheikh, Dakahlia, Damietta, and Port-Said.*

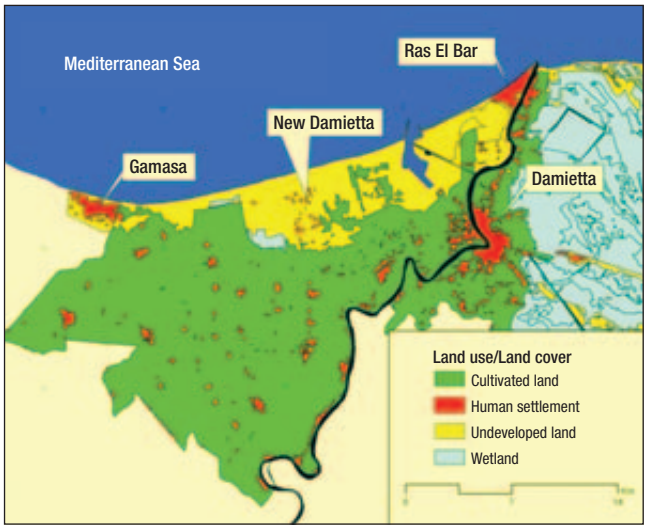
In its 2007 assessment, the Intergovernmental Panel on Climate Change declared the Nile Delta one of three sites on earth that are most vulnerable to sea level rise. The Panel projected a global average sea level increase of 18 to 59 cm by 2100. Several recent assessments suggest this figure could be much higher. The Delta's burgeoning population urgently needs to understand the changes under way and make informed choices about managing growth to secure their future against the effects of rising seas.

To guide these decisions, a research team linking the Coastal Research Institute of Egypt's National Water Research Center, Alexandria University's Institute of Graduate Studies and Research, and the Center for Development Services is bringing more precision to where and how Delta communities are most vulnerable, and assessing cost-effective options to help them prepare. Focusing on a section of coastline from Gamasa to Ras El Bar (see map in Figure 1), the team is assessing social and economic vulnerabilities, building on spatial mapping of the likely physical impacts of sea level rise. They aim to develop adaptation strategies and inform coastal land-use policy guidelines to reduce vulnerability and optimize trade-offs among stakeholders.

By engaging a range of affected people and institutions, the team hopes to widen participation in policy and planning processes. Two years into a 36-month research process, they are compiling a fuller picture of the situation and calculating the economic costs of several possible responses.

Ezbet El-Borg on the Nile Delta coast
Photo: IDRC / Mohammed Yahia

Figure 1. Map of study area, showing location of major centres and variations in land use and cover



Physical effects of sea level rise

The threat of sea level rise most directly affects the nearly 20 million people who inhabit the Nile Delta coastal areas. Erosion already devours up to 100 metres a year of coastline at some sites. The study area, like the rest of the Nile Delta, is experiencing land subsidence along with sea level rise. At an annual rate of about 3.0 mm at the Gamasa and Ras El Bar areas, by 2100 the area will have subsided about 30 cm. The major effects expected over the next century include flooding of coastal areas, rising water tables, and increasing salt levels in groundwater.

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Because the Delta's backshore is very low — as much as 1 metre below sea level in some areas — even small increases in sea levels may have serious repercussions. The team projects that by 2100, about 1.3% of the study area may be inundated. Gamasa will see the greatest percentage of its area flooded — nearly 12%.

Nearly 60% of the study area will experience a rising water table. This will have major impacts on agriculture and will damage buildings and infrastructure. Rising water tables impede drainage of agricultural land and cause saltwater intrusion into groundwater.

Other development pressures complicate the picture. Population growth upstream from the Delta means little Nile water now reaches the area; what does arrive is highly polluted. The result is declining soil fertility and a huge increase in fertilizer use as farmers struggle to maintain soil productivity.

Social and economic vulnerabilities

Researchers have identified the relative youth of the area's population, its limited education rates, and its dependence on natural resources and tourism as key social vulnerabilities.

The towns of Gamasa, Ras El Bar, and New Damietta are among the most vulnerable, according to an index the team developed. The immediate study area has a population of about 750,000: 43% urban dwellers and 57% rural.

About half the labourforce works in the service sector; many serve tourists who come for the sandy beaches. About 18% make a living from fishing or farming. Some agricultural lands in the study area already have higher levels of soil salinity and alkalinity, and rising water tables have lowered productivity.

Hard adaptation measures such as this sea wall are expensive to build and need maintenance due to wave damage.
Photo: IDRC / Mohammed Yahia

Nearly 10,000 jobs in Damietta governorate relate to the fisheries, and the Delta accounts for some 60% of Egypt's total fish catch.

For municipalities, the impacts of sea level rise will mean costly repairs and upgrades to infrastructure.

Almost one-third of the population is under 15 years. If rapid population growth continues, job creation will be a major issue. Low rates of formal education will hinder the region when it comes to adjusting livelihoods. About 62% of the total population in the study area is illiterate or has limited education. Women's workforce participation is low, though women play an important role in agriculture, especially in rural areas. As economic pressures increase, women are joining the informal labour market in growing numbers.

The quality of housing, infrastructure, and basic services is another concern. While most households have potable water and electricity, fewer have adequate sanitation. Slum dwellers are at greatest risk.

For municipalities that provide services and maintain infrastructure, these impacts will be costly. They will have to budget for repairing leaking sewers, upgrading water purification facilities, and improving groundwater control to protect foundations and drinking water supplies.

Weighing the trade-offs

The project's main contributions will be to help identify feasible, cost-effective adaptation options and to explore the trade-offs among them. Researchers have looked at the costs of options, from abandoning the worst affected coastal areas to investing in soft and hard infrastructure to protect shorelines. Certain options may be better suited to specific sites. For example,

Faces behind the research

Dr. Ibrahim Elshinnawy, Director of the Coastal Research Institute of Egypt's National Water Research Center

Lecturer, engineer, and researcher Ibrahim Elshinnawy draws on many strengths in leading this collaborative effort.

With degrees in Civil Engineering from Egypt's University of Alexandria (B.Sc.), the United Kingdom's University of Birmingham (M.Sc.), and the University of Arizona in the United States (Ph.D.), Dr. Elshinnawy has extensive experience in overseeing hydrological research and environmental impact assessment, and, most recently, addressing the impacts of climate change. As a lead author on the upcoming Fifth Assessment Report of the Intergovernmental Panel on Climate Change, he will help shape a chapter on Adaptation Planning and Implementation.

In the Nile Delta study, Dr. Elshinnawy believes public participation is crucial. "The most significant impact of this project will be the public awareness we raise among stakeholders," he says. To this end, the team has involved affected groups through seminars, workshops, and public meetings to engage them in defining adaptation policies and plans.

Elshinnawy points to the partnership with Alexandria University's Institute of Graduate Studies and Research and the Centre for Development Services as a key asset. "The cooperation among our three institutions in implementing the project has encouraged all the partners to contribute from best practices learned in their careers."

Photo courtesy of CoRI

coastal lowlands such as New Damietta and Gamasa may benefit from expanding dunes as storm buffers, creating beach sand reservoirs, and planting vegetation. Beach drain systems may be another option: the team estimates low to moderate installation costs for such drains, but relatively high maintenance costs, depending on the intensity of storms.

Measures to accommodate sea level rise might include improving the Gamasa drain system, one of the main Nile Delta drains. It is plagued by silting and prevents local fishers from navigating through to the Mediterranean. Relative costs of various measures appear in Table 1.

Gamasa farmer Bassem Farhat has seen his crops ruined by rising, salty groundwater. *Photo: IDRC / Mohammed Yahia*

Engaging policymakers and communities

Progress in engaging stakeholders was delayed by the political upheaval that gripped Egypt this year, but the research team plans extensive consultation with community representatives in the coming year. In addition to giving local people and decision-makers a more precise assessment of the impacts of sea level rise, the team hopes comparing the costs and trade-offs of various options will help these communities face the difficult choices ahead.

Table 1: Relative costs of adaptation options assessed in the study area

Option	Internal costs		External costs		
	Construction	Maintenance	Environmental	Social & Political	Economic & Infrastructure
No action	Zero	Zero	Moderate	High	High
Detached breakwaters	High	Moderate	Moderate	Low	Low
Groins	High	High	High	Low	Low
Nourishment of beach with sand	Moderate	Moderate	Low	Low	Low
Building artificial dunes	High	Moderate	Low	Low	Moderate
Beach drain systems	Moderate	High	Low	Low	Low

The project Adaptation to the Impacts of Sea Level Rise in the Nile Delta Coastal Zone illustrates progress in CCAA outcome area 1: **Research teams are better able to address climate-related vulnerabilities and to evaluate and develop adaptation options.**

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