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## Climate Variability and Water Resources in Kenya

### *The Economic Cost of Inadequate Management*

**E**ighty percent of Kenya is arid and semi-arid land; yet despite chronic water scarcity, the country has developed only 15 percent of its available safe water resources. Demand for water is expected to rise, owing to population increases and growing requirements for irrigated agriculture, urban and rural populations, industries, livestock, and hydropower.

Meanwhile, climate variability and the steady degradation of water resources cost Kenya at least 3.3 billion Kenyan shillings (Ksh) annually. Between 1997 and 2000, the El Niño–La Niña floods and droughts cost an estimated 290 billion Ksh, or 14 percent of gross domestic product (GDP) for the period. While it is not economical to avoid all costs, many of them can be minimized by increased investments in management and infrastructure, and more efficient, accountable, and participatory management and operation of the water sector.

Kenya's 1999 National Policy on Water Management and Development recognized effective water resource management as key to meeting basic human needs and providing for sustainable economic development in a country in which key sectors—agriculture, livestock, energy, tourism, industry, and fisheries—depend heavily on natural resources.

The recently established Water Resources Management Authority (WRMA), mandated by

the Water Act of 2002, establishes a framework for regulation of water resources, decentralizes water management decisions at the catchment level, and authorizes the imposition of water use charges. Its overall aims include increasing water storage capacity, decreasing flood damage, and providing greater security against shortages during droughts.

### Impacts of flood and drought cycles

Kenya experiences moderate droughts and floods every three to four years, and major droughts about every ten years. This pattern of floods and droughts is driven by weather patterns, including the El Niño and La Niña phenomena. El Niño flooding affects coastal settlements, urban areas, river valleys, and Western Kenya, including the fringes of Lake Victoria; La Niña droughts affect the whole country.

The agriculture sector (25 percent of Kenyan GDP, and 76 percent of water demand) is particularly sensitive to climate and to high rainfall variability, which ranges from 250 mm to 2,000 mm annually. Two-thirds of the country receives less than 500 mm annually, which is particularly hard on agriculture and livestock production (the latter contributes 50 percent of small farmers' income).

This note reports findings and key messages from *Climate Variability and Water Resources Degradation in Kenya: Improving Water Resources Development and Management* by Hezron Mogaka, Samuel Gichere, Richard Davis, and Rafik Hirji, World Bank Working Paper 69, Washington, DC, December 2005. This was one of 16 background papers for the World Bank Economic and Sector analysis, "Towards a Water Secure Kenya: Water Resources Sector Memorandum (2004) prepared by a team led by Rafik Hirji. Readers may download the complete paper from [www.worldbank.org/water](http://www.worldbank.org/water).



The value of livestock deaths alone from the 1997/98 drought was estimated at Ksh 5.8 billion. Main rural water supply structures, such as small dams and pans, and large dam (including Sasumua Dam supplying water for Nairobi) were damaged by flood-induced silting or outright destruction, as are pipelines, distribution networks, and irrigation infrastructure, such as intake structures, canals, and drains.

Power shortages from decreased hydropower (which provides over 65 % of the nation's electricity) during droughts result in income loss to industries and loss of productivity in the social and commercial sectors; they have pushed some businesses out of Kenya altogether. Tourism is affected by road and railway washouts, increased cost of water to tourist facilities, and by damaged ecosystems, such as coral reefs, beaches, and other wildlife attractions. Many people displaced from regular jobs turn to subsistence fishing, causing overfishing. The forestry sector, which is already under heavy stress as a result of massive deforestation, also suffers during droughts, with tree loss from illegal felling, fires, grazing, and disease. Erosion from cleared forest areas causes accelerated siltation and loss of storage capacity in water storage dams and pans. Sedimentation into the Indian Ocean also imposes a huge burden on the coastal coral reefs and in impacting jetties and other boat landing sites in and near Malindi.

Floods also cause extensive damage to water supply and sanitation infrastructure, including pipelines and pumping stations. During the 1999/2000 drought, people spent between three and eight hours lining up for or trekking to get water. Children's education is disrupted by long hours spent getting water; health suffers from flood- or drought-induced food shortages; and at least 60 percent of the top ten diseases in Kenya are waterborne or sanitation-related, such as typhoid, cholera, amoebic dysentery, and bilharzias.

## Water resource degradation

In the face of this dire picture, funding for managing Kenya's water resources has decreased, with serious consequences for water-allocation decisions, enforcement, and water-quality management. The country's water resources are now seriously degraded.

Principal causes of that degradation are:

- Excessive abstraction of surface water (rivers, lakes and wetlands) and groundwater
- Soil erosion and resultant turbidity and siltation
- High nutrient levels, causing eutrophication (oxygen depletion) of lakes and pans
- Toxic chemicals, including agricultural pesticides and heavy metals.

Excessive abstraction causes rivers to dry up during periods of low flow, leading to conflicts among water users. Groundwater is being used at unsustainable levels beneath Nairobi and other urban areas, and drilling and pumping costs are rising.

Most of Kenya's rivers—rivers are the country's main water supply—originate in forested regions. But deforestation from logging leads to increased runoff and sedimentation. During rainy seasons, this causes regional flooding and the silting of dams and pans. When clearing is combined with new settlements, dry-season water flows drop, punctuated by storm flows and increased sediment flows downstream. Sediment goes into reservoirs, reducing their economic life and the hydraulic capacity of water-conveyance facilities, and disrupting water-supply operations. For example, the Sabaki Waterworks, constructed in the late 1970s, required the addition of extensive settling basins upstream at a cost of US\$1 million.

Household water use is the second-largest after agricultural use. In cities, municipal sewage treatment plants are inadequate, inefficient, or not functioning. Industries discharge their waste into sewer systems or directly into open water. Contamination from toxic chemicals seeps into the water supply from storage facilities or landfills. Economic costs from pollution include public health problems, produce rejected by export markets because of contamination, and loss of tourism.

Agricultural fertilizers and pesticides are the largest non-point-source pollutants. Phosphorus and nitrogen flow into rivers and streams, where they contribute to eutrophication of downstream bodies of water and feed algal blooms and aquatic weeds. Eutrophication in Lake Victoria has made the bottom 30 meters of the lake anaerobic (or inhospitable to Nile perch), the most commercially valuable species in the region. In the 1990s, water

hyacinth occupied 90 percent of Lake Victoria's shoreline. Costs included impaired water transport, reduced fishing, higher costs, and lower water quality, and increased diseases and vermin. (Water hyacinth also brought economic opportunities, including manufacturing of chairs, paper and pulp, yarn, and rope.)

## The economic impact of rainfall variability and water resource degradation

We estimate that the 1997/98 El Niño floods cost Kenya 70 billion Ksh. That includes damage to water systems, roads, communications, and buildings; costs of treatment for waterborne diseases; and crop loss. The ensuing drought caused by La Niña, lasting from October 1998 to May 2000, brought at least Ksh 220 billion in crop losses, livestock loss, forest fires, fisheries damage, reduced hydro-power, reduced industrial production, and increases in the cost of getting water. These figures represent about 11 percent of Kenya's GDP in 1998/99 and 16 percent of the GDP in each of the two drought years that followed.

We used the same data to estimate long-term costs to the economy, arriving at an annual cost of floods and droughts of 16 billion Ksh, or about 2.4 percent of GDP. Floods take their toll largely in the form of capital losses—bridges, roads, water supply infrastructure. Droughts—estimated to cost 10.7 billion Ksh, or 1.6 percent of GDP—exact costs largely in annual production losses.

Costs of water resource degradation are even more difficult to estimate because they are incurred over long periods, often at sites distant from the source of degradation; we estimated those costs at some Ksh 3.3 billion annually, or about 0.5 percent of GDP. This figure includes costs of reservoir siltation, downstream flooding, crop reductions, tapping of lowered water tables, water treatment, and impediments to water transportation and fishing.

These estimates are conservative, reflecting only impacts that could be quantified. They fall on many sectors of the economy, including agriculture, water supply and sanitation, health, and power generation. We did not attempt to include indirect costs, such as loss of future employment opportunities,

noncompliance with international agreements, or increased conflicts over water access, although their impact was significant.

## Improving water resources development and management

Reforms of Kenya's water sector could substantially reduce costs of water resource degradation through better water resource management and greater investment in badly needed water supply infrastructure. Groundwater has considerable potential for boosting water supplies, with an estimated annual safe yield of 1.0 billion m<sup>3</sup> per year. In cities and towns, the development of surface water resources is preferable, in view of the volumes required and the limited recharge rates of groundwater.

Specific recommendations include:

*Political commitment.* The Ministry for Water and Irrigation should seek political support to make water resource management reforms a funded national priority. Cabinet support would help address economy-wide implications of water use and realign water management institutions.

*Developing water storage capacity.* The amount of water in storage is seriously inadequate for the population of a country that is growing rapidly and exposed to considerable rainfall variability. The recommendations of the 1992 Water Master Plan and 1998 Aftercare report should be reassessed in light of current needs—and acted upon with urgency. Mechanisms for improving the efficiency of water use should include surface water and groundwater banking, water reuse, demand management, repair of gauging stations, and investment in new water sources.

*Decentralization.* The WRMA is to oversee decentralization of water resources management functions (assessment, allocation, and enforcement at catchment level), accelerating decision making and encouraging more input from water users. Water use charges can provide a source of revenue for local enforcement activities.

*Participation.* All stakeholders must be included in planning and decision making, implementation, and operations through catchment area advisory committees and water user associations.

*Sustainability.* The Water Act includes provisions to finance water resource management through water user charges, catchment levies, and licenses to pollute. Upstream and downstream stakeholders must work with government agencies to manage land sustainably.

*Transparency.* Often, appropriate legislation and regulations are in place, but enforcement (of water permits, for example) is lacking. Increased transparency in the administration and enforcement of procedures, and improved community participation in decision making (and community acceptance of the need for regulations), will improve enforcement. This consequences of non transparent decisions on transboundary waters, including use and abstraction of Lake Victoria, can compound to serious inequities and tensions among riparian nations.

*Increasing the knowledge base for management.* Kenya has the institutional capacity to develop an early warning system to prepare for El Niño and La Niña floods and droughts, but more can be done to make these forecasts accessible; hydrometeorological data are currently neglected. Earlier warnings will reduce costs arising from the recurring cycle of floods and droughts.

The system for monitoring the extent and quality of the nation's resources must be repaired. Without adequate knowledge of climate, water use, and

sources of pollution, it is impossible to make wise decisions on water allocation, enforce pollution controls, plan and design water resources infrastructure, or target investments in better catchment management. The monitoring system could be funded, in part, through water user charges.

But knowledge and information alone are not enough to bring about changes. Enabling and empowering individuals to use that knowledge will require training and capacity building. Training will be required for the staff of the new WRMA, in such areas as water law, conflict resolution, water resources economics, environmental planning and management, and financial administration.

Specific pilot catchment or basin management projects should be developed and supported to serve as examples in other catchments. The pilot projects should be selected to address priority issues such as flood management in the Lake Victoria Basin, water apportionment, catchment degradation in the Mt. Kenya region, and groundwater management in arid and semi-arid areas.

The ongoing reforms in water resources management and development in Kenya that are supported by various bilateral agencies and the World Bank have begun to implement a number of recommendations made in the 2004 economic and sector work cited above.

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