

PROJECT OBJECTIVE

Arid and semi-arid countries worldwide are facing continuous increases in demand for fresh water supplies, mainly due to population growth and limited water supplies. These problems are exemplified in countries of North Africa and the Middle East where scarcity of water resources contributes to political instabilities, disputes, and conflicts. Studies have shown that the number of countries unable to meet their water needs to be self-reliant in food production were 12 in 1993, 16 in the year 2000, and will be 18 by 2025.

The objective of the project was to develop a replicable model for demonstrating different approaches to integrate renewable groundwater resources into water budgets in arid regions. The project conducted comprehensive studies leading to the development, validation and demonstration of techniques for evaluating the extent of alternative water resources arising from sporadic precipitation over large watersheds in arid and semi-arid areas, using the Eastern Desert of Egypt as the pilot site. The techniques encompassed the use of various geochemical and isotopic techniques, surface and ground water modeling, analysis of satellite images and digital elevation data, seismic and drilling data, field observations and exploration of development scenarios. The project developed procedures that can be used to accurately estimate the available groundwater resources and their distribution, quantity, and development potential, while also assessing adverse ecological effects that could result from the exploitation of the resources. The procedures can be applied in Egypt as well as in neighboring countries to enable planning for water management with minimum environmental, financial, and social risks. The project integrated the various components of the hydrological cycle, providing insight for linkages between various water resources. Formulated as a Targeted Research Project, the project was implemented as a partnership between Michigan State University and the University of Cairo.

RESULTS: PROCESS

INDICATOR #1: The sources, extent, and histories of groundwater in alluvial aquifers identified.

Chemical and isotopic analyses for groundwater samples were conducted and interpreted, and a subsequent report and a peer-reviewed manuscript were generated.

INDICATOR #2: Rainfall patterns over the Eastern Desert predicted.

A report on compiled meteorological data was produced, as were maps for precipitation patterns.

INDICATOR #3: A surface runoff model developed, and recharge to alluvial aquifers estimated.

Geologic, satellite, and digital topography data were compiled and digital mosaics were generated and co-registered from this information. Watersheds were delineated and a surface runoff-recharge model was developed, calibrated, and verified.

INDICATOR #4: A groundwater flow model constructed and groundwater flow in alluvial aquifers investigated.

A conceptual groundwater flow model was generated and verified for Wadies (Valleys) Assuity, Dara, and Qena. A peer-reviewed draft manuscript for data, model construction, validation, and application was produced. Digital products (inputs and outputs) were generated.

INDICATOR #5: A replicable model for neighboring Middle Eastern and Saharan countries is produced and thus contributes to the preservation of freshwater ecosystems in the region.

The benefits of the project will perpetuate because the results continue to be used routinely by the Ministry of Water Resources and Irrigation, which is primarily responsible for the development of Egypt's

water resources, and the Faculty of Engineering at Cairo University, which is largely responsible for advancing the research in this area.

The project was showcased as a model Methodology for Developing Groundwater Resources in Arid Lands at multiple international and regional events:

- World Water Forum 4 in Mexico (2006), within the World Bank session on selected best practices on groundwater development in the MENA Region;
- GEF International Waters Conference (Brazil, 2005) as a good example for GEF funded projects;
- GEF STAP/UNESCO workshop on Managed Aquifer Recharge (New Delhi, 2005);
- The 2nd Regional Conference on Arab Water: Action Plans for Integrated Development, organized by the NWRC (2004);
- Dissemination workshop with the participation of regional water experts with the Arab Water Council (Egypt, 2005);
- Workshop including international experts, in cooperation with the National Water Research Center and the Arab Water Council (2006);
- A special UNDP session on Arid Regions Hydrology was coordinated by the project to disseminate results and investigate potential future regional cooperation.

INDICATOR #6: Adverse ecological effects that could result from the exploitation of the investigated freshwater resources assessed.

An Environmental Impact Assessment was completed, and two workshops for dissemination of results were conducted.

INDICATOR #7: In-country and out-of-country scientific, technical, and research-oriented training and outreach activities centering on the assessment of alternative water resources provided.

A series of twelve training seminars was held on various groundwater-related management issues. One PhD and three MSc dissertations in disciplines relevant to the project were produced. Four peer-reviewed publications were produced. An interactive web site hosting the project's findings was generated, and web-based GIS and a mirror image web site were created at the Ministry of Water Resources and Irrigation. Two new water user associations were established, based in Alexandria. Two workshops were organized by the project to foster the participation of civil society and end users in regards to the management of groundwater resources.

KEY LESSONS LEARNED

- 1) In complex projects, where various organisations and various disciplines join to achieve common goals, the agreements on the roles, responsibilities and ownership of the future partners need to be included in a project document.
- 2) The management of the project through a task-based, deliverable-oriented grant distribution appears to be far more efficient than the lump-sum payment procedure.
- 3) The project is a unique example of the development of the equal partnership between Cairo University and the governmental departments/institutes. This precedent should be appreciated and further developed in practice.

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