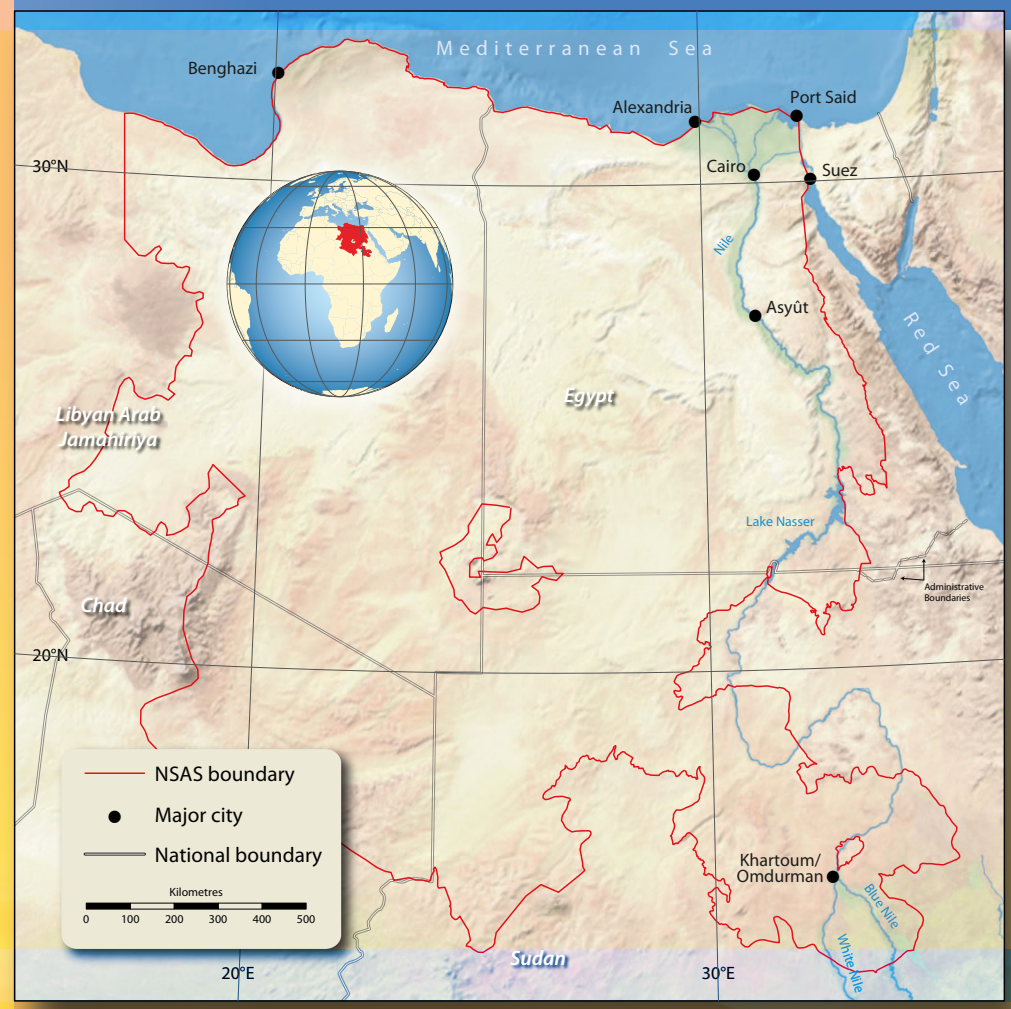
IAEA

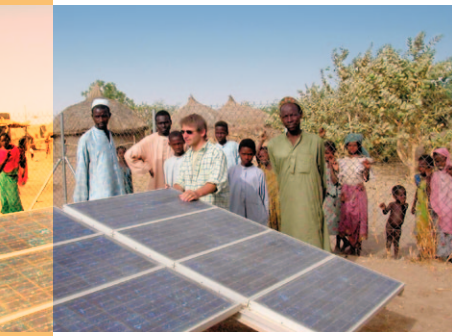
Water Resources Programme

Transboundary aquifers and river basins



Nubian Sandstone Aquifer System

Isotopes and modelling to support the Nubian Sandstone Aquifer System Project



The Nubian Sandstone Aquifer System (NSAS) underlies the countries of Chad, Egypt, Libyan Arab Jamahiriya and Sudan, the total population of which is over 136 million. It is the world's largest 'fossil' water aquifer system. This gigantic reservoir faces heavy demands from agriculture and for drinking water, and the amount drawn out could double in the next 50–100 years. Climate change is expected to add significant stress due to rising temperatures as well as changes in precipitation patterns, inland evaporation and salinization.

Groundwater has been identified as the biggest and in some cases the only future source of water to meet growing demands and the development goals of each NSAS country, and evidence shows that massive volumes of groundwater are still potentially available. Since the 1960s, groundwater has been actively pumped out of the aquifer to support irrigation and water supply needs. Over-abstraction has already begun in some areas, which leads to significant drawdowns and can induce salinization. In the approximately 20 000 years since the last glacial period, the aquifer has been slowly draining; the system faces low recharge rates in some areas, while others have no recharge at all.

The IAEA has been working with NSAS countries through national and regional projects to attempt to understand the aquifer's complexities. The joint Nubian Aquifer Project, undertaken by the IAEA, the Global Environment Facility (GEF) and the United Nations Development Programme (UNDP), is groundbreaking and challenging. The goal is to establish equitable management of the NSAS for sustainable socioeconomic development and the protection of biodiversity and land resources.

The IAEA, through the collaborative work of the nuclear applications and technical cooperation programmes, has been working with scientists in Chad, Egypt, Libyan Arab Jamahiriya and Sudan to develop a new and innovative 3-D model of the Nubian Aquifer. Three dimensional modelling permits accurate representation of water movement towards pumping areas and enables the

mapping of water movement through the aquifer with the use of particle tracking (tracing the movement of individual water parcels through the modelled aquifer system). This strategy can be used to estimate the age of water in the aquifer at any time and location. Only with 3-D tracking can young and old water flow paths be seen.

Recent advances in the analysis of krypton-81 (^{81}Kr) have made it the most promising isotope for identifying the uniquely ancient water existing in the NSAS. The groundwater ages determined using ^{81}Kr are more realistic than those based on other isotopes and they have been used to verify results of the Nubian Aquifer 3-D model. Krypton isotopes and modelling have made it possible to confirm the age of groundwater pumped from oases in the Western Desert of Egypt, which ranges from several hundred thousand to over a million years.

This project has been groundbreaking on many fronts: it is one of the first international transboundary aquifer water projects. Some of the most modern scientific techniques in existence are being implemented, with a focus on isotope hydrology. Many of the questions, activities and outputs will be new, and will require new management and legal structures on the part of the countries involved.

The main technical component of the project, involving assessment, has already been completed, and the next phase, designing a framework for implementation, is being launched. The ultimate goal is to use the model to anticipate and prevent adverse transboundary effects associated with extracting aquifer water. The model can be used by Member States to design future cooperative monitoring programmes and to assist in interpreting data.

At least as important as the technology has been the collaborative nature of this project. Scientists and staff of the water ministries in the four Nubian Aquifer countries participated in every stage of developing this model. All sides have agreed on a common language in terms of sharing and interpreting data and all are willing to adopt the model. The technical strategy was developed together.

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