IAEA Technical Cooperation Programme

Using environmental isotopes to investigate the interaction between surface water and groundwater in Morocco

Water sampling for chemical and isotope analyses in Morocco – scientists from CNESTEN sampling a spring in the Gharb plain. (Photo: Acil Ghassan/CNESTEN)

The challenge

Morocco is characterized by arid and semi-arid climates, and rivers are a major source of irrigation. However, rivers are often subject to problems of pollution, including indirect pollution from groundwater discharges as groundwater and surface water are often hydraulically connected. To meet its irrigation needs, Morocco needs to enhance the availability of good quality water resources.

The Sebou Basin covers approximately 40 000 km², or 6% of the surface area of Morocco, and has a population of about 6.2 million. The basin contains around 30% of the surface water resources of Morocco and is drained by the Sebou River, which rises in the Atlas mountains and flows for approximately 600 km before entering the Atlantic Ocean near Kénitra. The Sebou Basin is a major agricultural region with nearly 20% of the land under irrigation. The industrial sector, a consumer of water, is also highly developed. The interaction of surface and groundwaters in the Sebou Basin is poorly understood. A better understanding of their connectivity was critical for effective management of water resources.

The project

Morocco wished to better understand the interaction between surface and groundwater in the Gharb plain in the Sebou Basin. The plain is in the western part of the Sebou Basin, borders the Atlantic Ocean and contains four important aquifers, Gharb, Maamora, Mnasra and Drader Souiere. With the assistance of the IAEA, the country aimed to use isotopic and conventional techniques to obtain a clearer picture of water dynamics in the region.

Through its technical cooperation programme, the IAEA supported a study by the National Centre for Nuclear Energy, Sciences and Technology (CNESTEN), in collaboration with the State Secretariat in Charge of Water, that concentrated on using isotopic and conventional techniques. Training was provided through fellowships and scientific

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visits at the IAEA Isotope Hydrology Laboratory in Vienna, Austria, and the University of Avignon, France. Areas of learning included the contribution of isotopic tracers to the management and protection of water resources, sampling techniques, laboratory work, analysis and interpretation of data. Selected surface and groundwaters in the Gharb plain were subsequently sampled and analysed using isotopic and conventional techniques.

The impact

The project proved that isotope techniques were efficient tools to examine key hydrological problems in the study area. Analysis and interpretation of the data obtained from the water samples provided a clear picture of the degree of interaction between surface and groundwaters, and its impact on water availability and quality.

The main findings of the study carried out in the Gharb plain of the Sebou Basin were:

- A close hydraulic relationship was observed between the surface and groundwaters indicating an important contribution of surface water to the recharge of the Gharb aquifer;
- The high salinity of groundwater is caused by the weathering of evaporite rocks, and by sea water intrusion;
- The high concentration of nitrate (more than 40 mg/l) in the groundwater indicated a significant contamination mainly from agricultural activities.

The project enhanced national capacity to use isotope tools to better understand the interaction between surface water and groundwater in the Sebou Basin. The results of the study will support the efforts of the State Secretariat in Charge of Water to improve the management and sustainable exploitation of groundwater, thus contributing to socioeconomic development.

Scientists from CNESTEN sampling a spring in the Gharb plain. (Photo: Acil Ghassan/CNESTEN)

PROJECT INFORMATION

Project No: MOR7006

Project title: Using Environmental Isotopes to Investigate the Interaction between Surface Water and Groundwater

Duration: 2016-2017 (2 years)

Budget: €110 000

Contributing to:

Partnerships and counterparts

- National Centre for Nuclear Energy, Sciences and Technology (CNESTEN);
- State Secretariat in Charge of Water, Morocco.

Facts and figures

- Surface water samples were collected at 25 locations, and groundwater samples were taken from 90 wells and boreholes;
- Analyses for the stable isotopes oxygen-18 and deuterium, and for tritium, radon and major ions were performed at the CNESTEN laboratories. Ten groundwater samples were analysed for noble gases at the IAEA laboratory.

The science

Stable water isotopes of oxygen-18 and deuterium provide unique information to characterize and define sources, flows and interactions between different bodies of water, including mixing processes. Naturally occurring radionuclides such as tritium and carbon-14 are commonly used to estimate groundwater age, which is key information for assessing current rates of groundwater replenishment, transport processes in aquifers and their vulnerability to pollution. The concentration of noble gases such as helium, krypton and radon in groundwater is controlled by their solubility and is used to decipher infiltration areas or the temperature during recharge. The noble gas tools extend and enhance the routine use of radiocarbon for age estimation.