Integration of Remote Sensing and Geophysical Applications for Delineation of Geological Structures: Implication for Water Resources in Egypt

Abstract

North African countries struggle with insufficient, polluted, oversubscribed, and increasingly expensive water. This natural water shortage, in addition to the lack of a comprehensive scheme for the identification of new water resources challenge the political settings in north Africa. Groundwater is one of the main water resources and its occurrence is controlled by the structural elements which are still poorly understood. Integration of remote sensing images and geophysical tools enable us to delineate the surface and subsurface structures (i.e. faults, joints and shear zones), identify the role of these structures on groundwater flow and then to define the proper locations for groundwater wells. This approach were applied to three different areas in Egypt; southern Sinai, north eastern Sinai and the Eastern Desert using remote sensing, geophysical and hydrogeological datasets as follows: (1) identification of the spatial and temporal rainfall events using meteorological station data and Tropical Rainfall Measuring Mission data; (2) delineation of major faults and shear zones using ALOS Palsar, Landsat 8 and ASTER images, geological maps and field investigation; (3) generation of a normalized difference ratio image using Envisat radar images before and after the rain events to identify preferential water-channeling discontinuities in the crystalline terrain; (4) analysis of well data and derivations of hydrological parameters; (5) validation of the water-channeling discontinuities using Very Low Frequency, testing the structural elements (pre-delineated by remote sensing data) and their depth using gravity, magnetic and Vertical Electrical Sounding methods; (6) generation of regional groundwater flow and isotopic (^{18}O and ^{2}H) distribution maps for the sedimentary aquifer and an approximation flow map for the crystalline aquifer. The outputs include: (1) a conceptual/physical model for the groundwater flow in fractured crystalline and sedimentary aquifers; (2) locations of suggested new wells in light of the findings.