World Academy of Science, Engineering and Technology
International Journal of Mathematical and Computational Sciences
Vol:14, No:12, 2020

Application of Satellite Remote Sensing in Support of Water Exploration in the Arab Region

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Abstract : The Arabian deserts include some of the driest areas on Earth. Yet, its landforms reserved a record of past wet climates. During humid phases, the desert was green and contained permanent rivers, inland deltas and lakes. Some of their water would have seeped and replenished the groundwater aquifers. When the wet periods came to an end, several thousand years ago, the entire region transformed into an extended band of desert and its original fluvial surface was totally covered by windblown sand. In this work, radar and thermal infrared images were used to reveal numerous hidden surface/subsurface features. Radar long wavelength has the unique ability to penetrate surface dry sands and uncover buried subsurface terrain. Thermal infrared also proven to be capable of spotting cooler moist areas particularly in hot dry surfaces. Integrating Radarsat images and GIS revealed several previously unknown paleoriver and lake basins in the region. One of these systems, known as the Kufrah, is the largest yet identified river basin in the Eastern Sahara. This river basin, which straddles the border between Egypt and Libya, flowed north parallel to the adjacent Nile River with an extensive drainage area of 235,500 km2 and massive valley width of 30 km in some parts. This river was most probably served as a spillway for an overflow from Megalake Chad to the Mediterranean Sea and, thus, may have acted as a natural water corridor used by human ancestors to migrate northward across the Sahara. The Gilf-Kebir is another large paleoriver system located just east of Kufrah and emanates from the Gilf Plateau in Egypt. Both river systems terminate with vast inland deltas at the southern margin of the Great Sand Sea. The trends of their distributary channels indicate that both rivers drained to a topographic depression that was periodically occupied by a massive lake. During dry climates, the lake dried up and roofed by sand deposits, which is today forming the Great Sand Sea. The enormity of the lake basin provides explanation as to why continuous extraction of groundwater in this area is possible. A similar lake basin, delimited by former shorelines, was detected by radar space data just across the border of Sudan. This lake, called the Northern Darfur Megalake, has a massive size of 30,750 km2. These former lakes and rivers could potentially hold vast reservoirs of groundwater, oil and natural gas at depth. Similar to radar data, thermal infrared images were proven to be useful in detecting potential locations of subsurface water accumulation in desert regions. Analysis of both Aster and daily MODIS thermal channels reveal several subsurface cool moist patches in the sandy desert of the Arabian Peninsula. Analysis indicated that such evaporative cooling anomalies were resulted from the subsurface transmission of the Monsoonal rainfall from the mountains to the adjacent plain. Drilling a number of wells in several locations proved the presence of productive water aquifers confirming the validity of the used data and the adopted approaches for water exploration in dry regions.

Keywords : radarsat, SRTM, MODIS, thermal infrared, near-surface water, ancient rivers, desert, Sahara, Arabian peninsula
Conference Title : ICSRD 2020 : International Conference on Scientific Research and Development
Conference Location : Chicago, United States
Conference Dates : December 12-13, 2020