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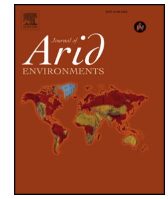

Delineation of groundwater potential (GWP) in the northern United Arab Emirates and Oman using geospatial technologies in conjunction with Simple Additive Weight (SAW), Analytical Hierarchy Process (AHP), and Probabilistic Frequency Ratio (PFR) techniques

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ABSTRACT

In the United Arab Emirates (UAE) and Oman, an arid climate coupled with rising populations have placed increased demand on scarce water resources. This study performs groundwater prospecting in the northern UAE and Oman by delineating Groundwater Potential (GWP), the relative likelihood of a location to accumulate groundwater, by modelling the influence of physiographic variables affecting groundwater accumulation. Remote sensing data from ASTER, Landsat-8, Shuttle Radar Topography Mission (SRTM), and Tropical Rainfall Measuring Mission (TRMM) were used to map relevant physiographic variables including elevation, slope, curvature, drainage density, Topographic Wetness Index, lithology/land cover, lineament density, rainfall, and groundwater-induced cool thermal anomaly frequency (GW CTA). Three different techniques were used for the GWP model including Simple Additive Weight (SAW), Probabilistic Frequency Ratios (PFR), and the Analytical Hierarchy Process (AHP). The three derived GWP maps were assessed through validation by comparing the locations of 645 water wells, 49 natural springs, and field observations of groundwater features to GWP zones. The SAW and AHP maps were deemed valid with agreement to moderate or greater potential zones for wells at 98% and 92% and springs at 63% and 86% respectively, and all field observation locations for both maps. Based on the SAW and AHP maps, the highest GWP is located in the Dubai/Sharjah emirates due to optimal runoff accumulation, infiltration conditions, and subsurface storage capacity. Findings of this study demonstrate integration of remote sensing data with the adopted geospatial techniques is a practical method of groundwater prospecting in similarly data scarce, arid environments.

1. Introduction

Potable water is arguably the most important natural resource as it is necessary to sustain human populations. In many desert regions, surface waters–if present, are often ephemeral, leaving groundwater as the only exploitable water resource. Aquifers in desert regions are easily overdrawn, as recharge from scarce and irregular rainfall is often negligible compared to water demand, serving as the crux for water scarcity issues in desert regions worldwide.

Countries in the Middle East have exploited abundant energy resources for economic development, but increased industrial and agricultural demands and rising populations are depleting regional water resources (Joodaki et al., 2014). Considered the most water scarce region in the world, water availability in the Middle East is well below the global average of 7000m^3/person/year at an estimated 1200 m^3/person/year (The World Bank, 2010). Water availability is expected to decrease further as populations in the Middle East and North Africa region are expected to grow from roughly 300 million as of 2010 to over 500 million in 2015 (The World Bank, 2010). Consequently, the Middle East is rated as having high to severe water risk

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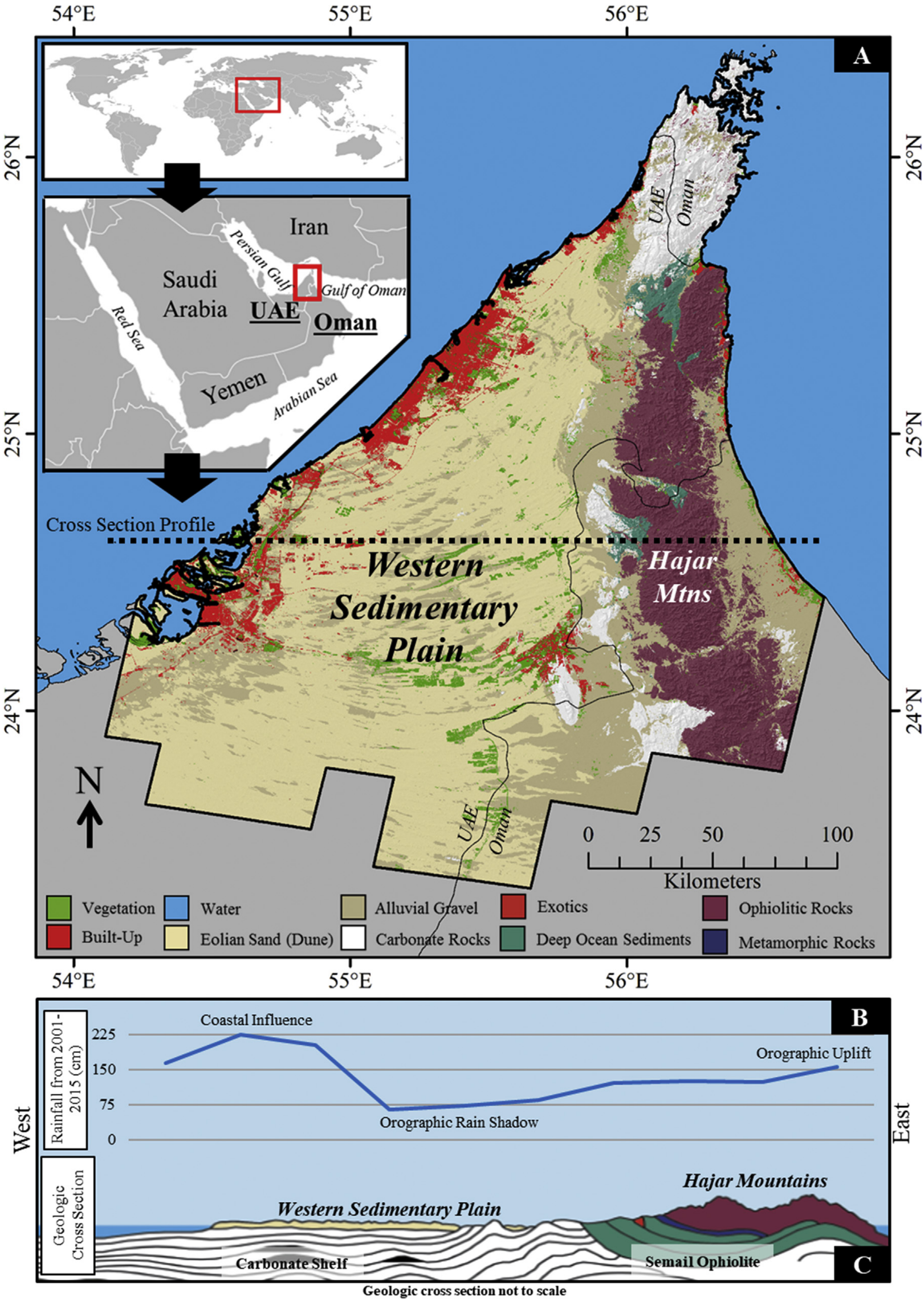

Fig. 1. Study area physiographic map and cross-section. A) Physiographic map with focus on general lithology/land cover (derived from ASTER and Landsat-8 multispectral products, hill shade generated using SRTM 30m DEM v.3). B) Cross section of accumulated rainfall (derived from TRMM TRMM 3B42 V7 Daily derived product). C) Generalized geologic cross section (Modified from Environment Agency-Abu Dhabi, 2011). The majority of the UAE population resides in the study area. The study area can be divided into east-west regions based on physiographic hydrologic/hydrogeolic influence: the Hajar Mountains and the Western Sedimentary Plain. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)