Mapping of factors controlling groundwater recharge, discharge and quality in Abu Dhabi Emirate, UAE using Remote Sensing and Geographic Information System

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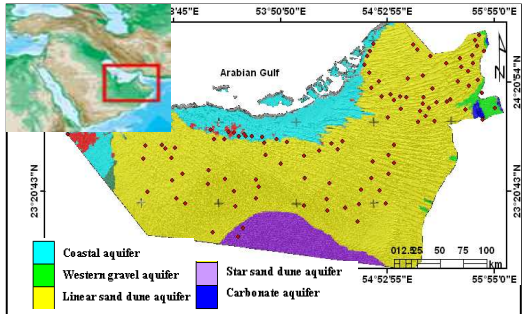


Background

The availability of surface water in the United Arab Emirates (UAE) is limited because of the low rainfall rate and high evaporation rates. Additionally, the UAE has been experiencing rapid urbanization and intensive human activities. Mapping of hydrological, environmental and geological elements and investigate their influence on groundwater accumulation and salinity are key components to understand the hydrological setting of Abu Dhabi Emirate.

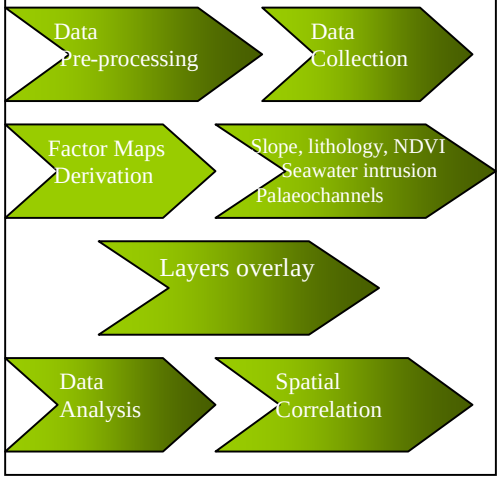
In Abu Dhabi Emirate, paleochannels (flow directions), lithological units and topographic slope result in increased groundwater accumulation. Agricultural activity, aquifer thickness, shallow water table and seawater intrusion result in increased groundwater salinity and contamination.

Although several studies have been done previously to investigate the influence of lithological units and land development on groundwater pollution, remote sensing and geographic information system (GIS) for mapping geological and hydrological elements control groundwater accumulation and groundwater quality over the entire region have not been applied in detail. This study aims to map geological, hydrological and environmental elements such as lithological and structural units, paleochannels, sea water intrusion and vegetation density from remote sensing data using automated algorithms over regional scale and integrates remote sensing GIS to investigate their influence on ground water accumulation and quality over regional scale.

Objective

This study aims to map geological, hydrological and environmental elements such as lithological and structural units, paleochannels, sea water intrusion and vegetation density from remote sensing data using automated algorithms over regional scale and integrates remote sensing GIS to investigate their influence on ground water accumulation and quality over regional

Methods



Results

The results showed that the carbonate rocks of Hafeet and the Oman Mountains (sources of recharge) are preferable recharge areas and, in the same time, sources of HCO_3, Ca, Mg, Cl and Na in the groundwater. The palaeochannels and hydraulic head maps showed that the recharge areas in the east and discharge area in the west and the groundwater salinity increases in the flow directions.

The results also showed positive correlation between the spatial distribution of NDVI (Figure 1a) and groundwater discharge areas and NO_3 concentration in the groundwater. The topographic slope (Figure 1b) helped in identifying surface water infiltration rate, while seawater intrusion map (Figure 1c) indicates that the coastal aquifer is hazardous area of very high salinity. The aquifer was classified as recharge-discharge area (Figure 1d).

The flow system in Abu Dhabi Emirate can be categorized into three types: (1) local scale flow, (2) intermediate scale flow, and (3) regional-scale flow. The local flow is stretched from Mountainous areas to the western gravel aquifer and contains fresh water. The intermediate flow is stretched from western gravel to sand dune and contains brackish water. The regional flow is starched from sand dune area to coastal areas and contains saline water. At the regional scale flow of the study area (coastal aquifer), the flow lines indicate regional groundwater.

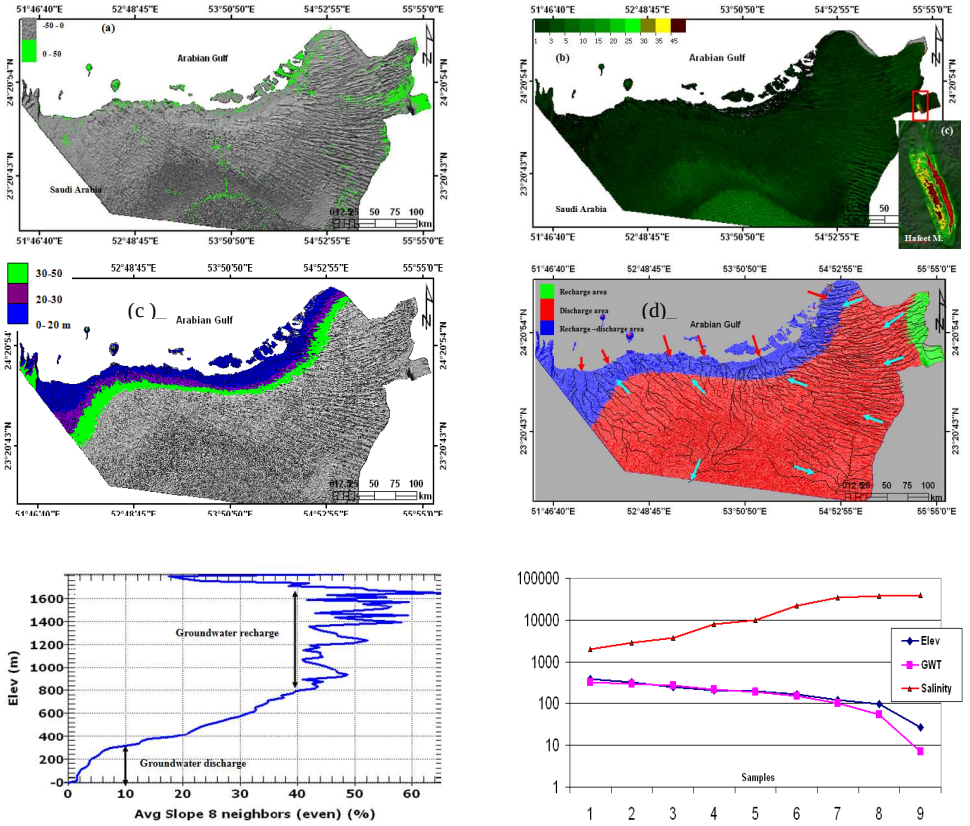


Figure 1. Maps of NDVI (a), slope (b), seawater intrusion (c), groundwater discharge, preferential recharge and recharge–discharge areas (d) are draped over DEM, and graphs of elevation via topographic slope (e), and altitude via hydraulic head and groundwater salinity (f).

Conclusion

The current study presented an integrated approach based on a set of automated algorithms, which uses multi-sources remote sensing data to map factors controlling groundwater recharge, discharge and quality across remote regions. Factors controlling groundwater recharge, discharge and quality were effectively identifies by mapping lithology, paleochannels and topographic slope, hydraulic head, NDVI and seawater intrusion.

The current study presented an integrated approach based on a set of automated algorithms, which uses multi-sources remote sensing data to map factors controlling groundwater recharge, discharge and quality across remote regions. Factors controlling groundwater recharge, discharge and quality were effectively identifies by mapping lithology, paleochannels and topographic slope, hydraulic head, NDVI and seawater intrusion. mapping factors controlling groundwater recharge and discharge and quality using remote sensing and GIS, new maps were conducted and hydrological information is provided for numerical modeling and water balance analysis with time and cost effective. Finally, it would be interesting to map factors controlling groundwater recharge, discharge and quality from high resolution of remote sensing data.