15th International Congress of the Geological Society of Greece
Athens, 22-24 May, 2019 | Harokopio University of Athens, Greece
Bulletin of the Geological Society of Greece, Sp. Pub. 7 Ext. Abs. GSG2019-035

Spatiotemporal Variability of Water Table Levels in Al Ain Region, United Arab Emirates

A. Abuelgasim and M. Elkamali

National Water Center, Department of Geography and Urban Planning, United Arab Emirates University, Al Ain, UAE, a.abuelgasim@uaeu.ac.ae

Abstract

Management of groundwater recourses has been one of the most critical challenges facing human beings in the past few decades. Mapping groundwater levels and fluctuations provide a valuable source of information for various applications of human and urban activities as well as their impact on the environment. Al Ain region in the United Arab Emirates has been facing serious problems with the depletion of its groundwater resources in the past few decades. This problem has been intensified by the rising urban population, and expansion in agricultural activities. It has been judged to be prudent to continuously monitor groundwater levels from different observations well. Such study shall be useful for integrating water resources management, planning groundwater development, and sustainable water resources for agricultural and urban utilization. The water table levels from different observation wells around Al Ain city were interpolated using deterministic and stochastic interpolation techniques to predict the spatial distribution of water levels for the period between 2014 to 2017. It has been observed that groundwater level ranges from 2 m inside Al Ain city to 154 m at Remah district western of Al Ain city. The fluctuations of the groundwater level during the mentioned period will be presented and discussed. Furthermore, the study will provide the necessary steps in generating a hydrogeological model for sustainable water resources management.

In the Arabian Peninsula and particularly in United Arab Emirates (UAE) groundwater is a major source of fresh water supply particularly to agriculture. More recently, the socio-economic development, the high population growth and expansion in agriculture have placed enormous strains on the limited available water resources. Achieving sustainable water use and management practices is thus of vital importance. The development of an integrated water management strategy based on the long-term monitoring of changes in groundwater storage and its seasonal dynamics is a first step towards this goal.

Groundwater level in Abu Dhabi, United Arab Emirates (UAE) has been continuously subject to changes in both level and salinity. Due to the arid characteristics of the region, the enormous water consumption to meet the intensive urbanization and expansion processes comes mainly from the groundwater and desalinization plants. In addition, demands from agriculture, domestic and industrial sectors participate with more than 65% of the water consumption mainly from groundwater resources. A decrease of the groundwater level by as much as 80 m has been reported in some areas in Abu Dhabi emirate. Furthermore, the arid climate in UAE with less than 100 mm a year in average combined with the high evaporation rate (2-3 m/year) and the low groundwater recharge (4% of total annual water use) are more contributing to the scarcity of these resources.

Water wells in the study area offer information about depth to water provided from Environmental Agency of Abu Dhabi, some of these wells are productive wells which they use for farming and some are observation wells to monitor water table dynamics. Information obtained from both types of wells were used for studying aquifers parameters (permeability, porosity, storativity, so on), groundwater exploration, and furthermore for investigating land surface deformations. In recent years deterministic and stochastic interpolation techniques have been utilized to predict the spatiotemporal variability of water table levels inside the GIS environment. The benefit of using GIS environment that is providing better use of interpolation techniques to predict the spatiotemporal variations. This paper is focusing in identifying the variations of water table levels over space and time in Al Ain region to provide better understanding of groundwater dynamics in the study area.

Both stochastic and deterministic techniques provide a means for studying the spatiotemporal variability of water levels from close points. Stochastic interpolation methods import the spatial variability of the variable by using the spatial autocorrelation property, while deterministic interpolation methods use the values of the variable only. Stochastic interpolation techniques use both statistics and mathematical functions for interpolation, while deterministic interpolation techniques use only mathematical functions. The main methods of deterministic interpolation available in GIS software include triangulation with linear interpolation, Inverse Distance Weighted (IDW), spline and spline modified.

Stochastic methods have the capability of producing a prediction surface, but they can also provide some measure of the certainty or accuracy of the predictions. Ordinary kriging is a stochastic method that is common in GIS analysis tools. Kriging is similar to IDW (deterministic method) in that it weights the surrounding measured values to derive a prediction for each location. However, the weights are based not only on the distance between the measured points and the prediction location but also on the overall spatial arrangement among the measured points.

When using Kriging interpolation technique, the spatial autocorrelation is studied using the empirical semi variogram to investigate that close points are mores similar than far away points. Empirical semi variogram has variety of models that use to fit the plotting between semi-variance and the distance between points. The best fit model should be selected carefully because it will affect the prediction surface.

The provided water table levels data were in form of depth to water in meter with lithological description. These data were processed in ArcGIS software package to create point map showing the spatial distribution of water wells. In order to generate interpolated surface using stochastic technique the Geostatistical wizard of ArcGIS has been used to utilize interpolated surface of water table levels. Geostatistical wizard allows to construct and manipulate semi-variogram model to optimize the interpolation process and Kriging type used was Ordinary Kriging. Generating interpolation surface using Kriging method provide additional benefit of creating standard deviation surface to evaluate the accuracy of the interpolated surface. On the other hand, the interpolated surface using deterministic technique was generated using IDW method. A comparison between both methods have been conducted.

This study showed that depth to water increased during May to November (drought season) and return to decrease between December to April (rainy season). Interpolated surfaces generated from stochastic interpolation technique showed higher accuracy than surfaces generated from deterministic interpolation technique. Standard deviation surface maps from Kriging method showed a consistent value to consider the generated surface as optimum results. The trend of water table levels during this period showed a significant decrease and this can be result of the consistent drop in rainfall at the study area between 2014-2017 coupled by increase in groundwater withdrawals.

Acknowledgements

This work is supported by a grant from the National Water Centre of the United Arab Emirates University under Grant number 31R155-Research Centre- NWC -3-2017.