Using spatial analyses tools to study the impact of changing demographics, agricultural extents and urban growth on water quality and availability in the Amman-Zarqa basin, Jordan

Khaled Abdallah Alqadi

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Certification

I certify that the substance of this thesis has not already been submitted for any degree and is not currently being submitted for any other degree or qualification.

I certify that any help received in preparing this thesis, and all sources used, have been acknowledged in this thesis.

Khaled Abdallah Alqadi

[redacted]

Abstract

Jordan is one of the countries in the world facing a water crisis, as current water usage in the country is unsustainable in terms of both supply and quality. The water demands of Jordan have led to a decimation of underground water with a rise in salinity in the aquifers. The high population growth and pulse immigration stemming from worsening regional conflicts has led to serious water shortages in urban centres and villages. Jordan faces almost inevitable social conflict and the irrevocable loss of agricultural land due to the increase in refugee numbers from neighbouring countries and general population growth. With the consequences of climatic fluctuations, such as rainfall, there has been a significant shift in the agricultural sector towards intensification and a high reliance on irrigation.

The underground water sources are an important source of drinking water, agricultural production and industrial use. Underground water in Jordan is inherently susceptible to contamination from anthropogenic activities, which to remedy is difficult and costly. Identifying and preventing the sources of underground water pollution is critical for underground water management.

The aims of this project were primarily to address the water problem in Jordan through identifying the extent of the resource reduction, and establishing the reasons for its decline in quality. In this context we also set out to identify the changes in the demographics, urban areas and agricultural areas and the impact of these on water quality, in terms of increased demand for fresh water, and how these changes will affect water quantity and quality. Secondly we investigated monthly variation in water quality in the Amman-Zarqa basin to see the temporal changes of the underground water quality with respect to selected chemical variables such as conductivity, nitrate, pH and ammonium, using different techniques such as Geographic Information Systems (GIS) to identify the fluctuations in the values of the selected chemical elements in the underground resources, as well as to localize the area of high risk of contamination. Thirdly we mapped long term changes in the underground water quality to see the changes in the selected elements between 2004 and 2010, and linked these changes with land use and land cover for the same period. This overlay helps explain how the changes in the land use and land cover have a significant impact on water quality in terms of urban, industrial and agricultural changes. Finally, having identified the problems of declining water quality and availability in Jordan, we suggest means of improving water management in the country, in the long term. This research will assist the country in rethinking long term planning to solve its water issues.

The results show that the spatial distribution of the elements in the underground water changed from time to time. The results indicate fluctuations in the values of the selected chemical elements in the underground water and a major localization of high values of hotspots in all parameters, during the study period. The areas of high values of hotspots were dominated by urban infrastructure, industries, and wastewater treatments and irrigated lands, while land use and land cover changes also had a significant impact on water quality. These findings have positive implications for understanding water quality across the region and for the management of water in the aquifers. The study concludes that the only means of improving the management of water in Jordan may be desalination from the Red Sea as a long-term viable option to meet the growing domestic water needs in Jordan.

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