Impact of Spring Water Qualitative Assessment on the Environmental Management System in the West Bank

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Keywords
Natuv catchment • Spring water • Hydrochemistry • Water quality • Pollution • Environmental information system

1 Introduction

This study explores the use of water quality data for groundwater protection management. The urban related environmental expansion acts as pollution indicators for the spring water quality. Groundwater quality indicators were mapped and integrated with spatial information about the surrounding environment. It is one of the most important sensitive recharge areas to the Western Aquifer underlying the basin, putting more intensive efforts on spring-water environmental protection management. Groundwater quality indicators were mapped and integrated with spatial information about the surrounding environment for groundwater protection management. High quality freshwater resources are essential for economic growth, quality of life, and environmental sustainability. The quantity and quality of potable water varies over time and space, and is influenced by natural and man-made factors including climate, hydrogeology, management practices, and pollution. In the West Bank, the use of spring water for domestic purposes has increased in the last few decades because of a rapid increase in population, which is referred to as natural growth. The study area is the Natuv catchment, which is located to the west of the city of Ramallah. The springs are the natural outlets of the aquifer in the study area, due to the karstified nature of the limestone and dolomite outcroppings there. Most of the springs are distributed in the middle part of the study area and the flow discharge of these springs is greatly affected by the intensity of precipitation. Springs in the study area are an outcrop of perched aquifers. There are 130 springs located within the Natuv catchment. The wide distribution of cesspools and septic tanks with inadequate quality controls, graywater disposal into gardens and road ditches, and the uncontrolled disposal of untreated municipal sewage into valleys may cause rapid contamination of aquifer systems through karstic conduits in the area (Qannam 1997). There have been very few hydrochemical studies conducted in the study area, leaving environmental managers with little data to use in groundwater protection efforts. Therefore, a chemical and biological investigation is essential for the authorities to implement successful management plans. The main outcrop formations are Albian to Turonian age (SUSMAQ 2003) (Fig. 1). The groundwater is recharged mainly from precipitation falling on the mountains of middle of the West Bank from direct infiltration along the karstified outcrops in the mountainous and sloped areas in the eastern part of the aquifer system.

2 Materials and Methods

Three sampling campaigns were conducted at 17 springs in the Natuv surface water basin in Western Ramallah (48 samples). The samples were analyzed for physico-chemical parameters: major ions, trace elements and Total and Fecal Coliform bacteria. Analyses included physical parameters pH, temperature, and EC, and concentrations of chemical constituents Na^+, K^+, Ca^{2+}, Mg^{2+}, Cl^-, HCO_2^-, NO_2^{2-}, and SO_4^{2-}. The hydrochemical and microbiological analytical tool was performed using laboratory techniques.

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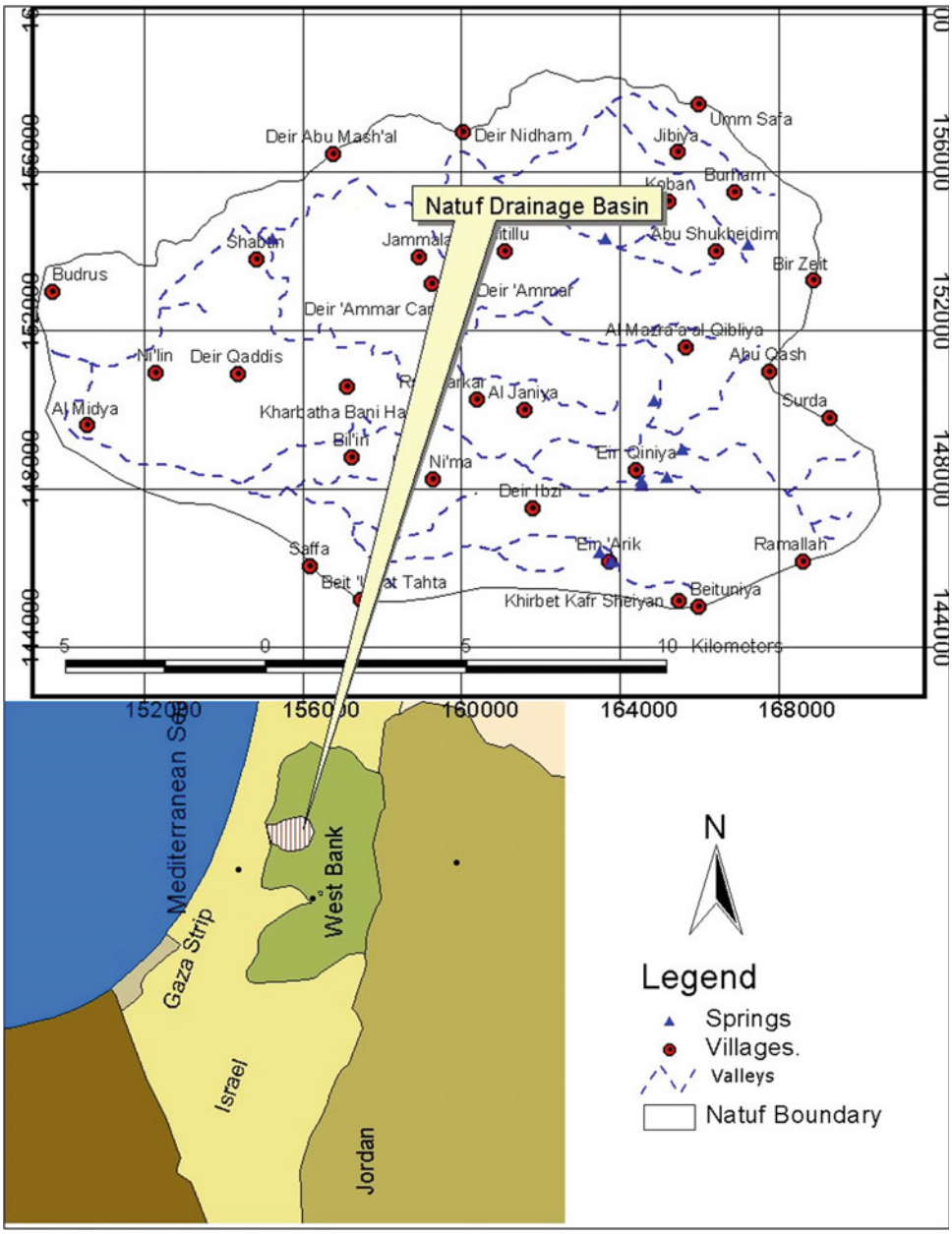

Fig. 1. Location of the Natuv drainage basin in the West Bank (Shalash and Ghanem 2007)

3 Results and Discussion

Results were used in a regional water quality trend assessment and the spring water was found to be polluted in the springs located inside the populated areas. Relationships between different hdrochemical parameters reflect the carbonate nature of the aquifers. Spring water in the study area is found to be alkaline with average pH ranging from 6.4 to 8.3 and the EC values ranging from 410 to 1307 µS/cm. The average concentrations of anions and cations in all water samples are within WHO standards, with the exception of Calcium in some samples. Some samples contain concentrations of trace elements Co, Zn, Sr, Mn, B, Al, Cu, Fe, and Ba, above WHO standards. Hydrochemical formulae show that most springs in the study area have a water type of Ca-Mg-HCO_3^-. Samples were tested for FC and TC and it is concluded that all of the springs are contaminated with coliform bacteria. A Piper Classification diagram shows that the type of spring water in the study area is "Normal earth alkaline water with prevailing hydrogen carbonate and sulfate or chloride". Its results indicate that Ca^{2+} is the dominant cation and HCO_3^- is the dominant anion, supporting the spring water classification to be Ca^{2+}-HCO_3^- type. This reflects the calsic nature of the rocks, where the springs are emerging. A Wilcox diagram (Wilcox 1955), which plots Sodium adsorption ratio (SAR) versus Conductivity,

shows that most samples fall within the S1, C2 region. This means that they are in zones of medium salinity to low SAR, which is good for agriculture. Other springs fall within S1, C3 region, meaning that they are in zones of high salinity to low SAR, which is permissible for agriculture. With respect to EC and Na^+ values, the spring water is good for irrigation in all three rounds (all times of year). All samples had SAR values lower than 10, and following SAR (U.S. Geological Survey 2006) classification, can therefore be considered excellent for irrigation. Spring water quality assessment involves physical, chemical, and microbiological parameters, and depends on the availability of these data. To facilitate management efforts, measurements should be readily available for the planners to have them as a base for the setting the protective areas for these springs. Different quality indicators will be more important for assessing future management of spring water usage in the Natuv catchment. The study demonstrate that the urban expansion and it's related environmental affects put more threats on the qualitative measures of the spring water in the catchment. Emphasis was put on creating a system that could raise community awareness about the quality of water resources and aid in groundwater management plans. Results were used in a regional water quality trend assessment and the spring water was found to be polluted in the springs located inside the populated areas. Relationships between different hydrochemical parameters reflect the carbonate nature of the aquifers.

4 Conclusion

The presence of Coliform bacteria and elevated concentrations of heavy metals point to human impacts on water quality and indicate the need for groundwater protection efforts in the study area. The study demonstrates that the urban expansion and it's related environmental affects put more threats on the qualitative measures of the spring water in the catchment. Groundwater quality has been assessed through the analysis of physico-chemical parameters and major ions in samples from 17 springs in the Natuv Catchment in Western Ramallah. The pH of Spring water in the study area was ranging between 6.4 and 8.3 and the range of measured electrical conductivities was 410–1307 µS/cm. With the exception of Calcium, average concentrations of anions and cations in all spring water samples are below WHO standards (WHO 2007). The following trend is observed for anion concentrations: $HCO_3^- > Cl^- > SO_4^{2-} > NO_3^-$, while cation concentrations follow the trend $Ca^{2+} > Na^+ > Mg^{2+} > K^+$. This reflects the predominance of calcium carbonate in the aquifer materials. Average values for most physico-chemical parameters indicate that the water is suitable for drinking purposes. However, analysis of trace elements indicates that spring water in the study area contains concentrations of Co, Zn, Sr, Mn, B, Al, Cu, Fe, and Ba that are higher than the limits specified by WHO standards (WHO 2007). Concentrations of some trace elements in R2 are much higher than those in R1 and R3. This is attributed to the lack of dilution by rainfall runoff during the summer, when these samples were taken. The spring water type in the study area is "Normal earth alkaline water with prevailing hydrogen carbonate". With respect to EC and Na^+ values, the spring water is good for irrigation in all three rounds. Samples were tested for FC and TC and it is concluded that all of the springs are contaminated with coliform bacteria, and are therefore not suitable for drinking purposes without treatment. The presence of Coliform bacteria and elevated concentrations of heavy metals point to human impacts on water quality and indicate the need for groundwater protection efforts in the study area. The study demonstrates that the urban expansion and it's related environmental affects put more threats on the qualitative measures of the spring water in the catchment.

References

Qannam Z. Environmental status and water quality evaluation of the groundwater resources in Bethlehem-Hebron region/Palestine. M. Sc. thesis. University of Jordan; 1997.

Shalash I, Ghanem M. Hydrochemistry of the Natuf drainage basin in Ramallah area/West Bank. J Environ Geol. 2007;55:359–67.

SUSMAQ. Numerical regional pollution model of the western aquifer basin. Report SUSMAQ—POL #47, sustainable management of the west bank and gaza aquifers. School of Civil Engineering and Geosciences, University of Newcastle upon Tyne; 2003.

U.S. Geological Survey. Water-quality characteristics, including Sodium-absorption ratio, for four sites in the powder river drainage basin, wyoming and montana, water years 2011–2004. Scientific Investigations Report. 2006;5113:5–6.

Wilcox LV. Classification and use irrigation waters. US Dep. Agric. Cric. 969. Washington, D.C;1955. p 19.

WHO Standards—World Health Organization. Guidelines for drinking-water quality, vol. 2; 2007.