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QUALITATIVE WATER DEMAND MANAGEMENT FOR RURAL COMMUNITIES IN THE WEST BANK

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SUMMARY – Groundwater management in the West bank is affected by the randomly distributed cesspits in the qualitative point of view, especially in rural communities. Accordingly, the shallow aquifer in the eastern and western groundwater basins is deteriorated; high concentrations of nitrate and sulfate were detected larger than the WHO standards. Microorganisms were detected in some springs inside rural communities in Ramallah area. This could be reflected on the water supply for these communities for the fact that these water sources are the major sources for drinking and agricultural purposes. This will cause a demand pressure on the future demand for the available water resources in the West Bank.

Keywords: water quality, nitrate and sulphate concentration, micro-organism

1. INTRODUCTION

The water sources in the West Bank's originate from the rain occasional snow that precipitates during winter seasons over the area. Most of the groundwater in the West Bank occurs in fissures, karstic features and joints of the mostly carbonate Ajlun group of Late Cretaceous age. The upper Cretaceous formations comprise the regional lower and upper Cenomanian aquifer systems (Blake and Goldschmidt, 1947). The range in thickness is from 400 to 900 m.

Among one of the most serious problems facing the Palestinian groundwater is the wastewater. Most of the areas in the West Bank are not served by wastewater collection systems, instead cesspits are used. When they are full they are emptied by sewage tankers and the contents are disposed of in a nearby sewage dump or simply into wades surrounding the area. A cesspit with an average volume of 25 m^3 is usually emptied once every 5 to 6 months. Obviously, no treatment prior to disposal occurs in most of the areas. Wastewater quantity as well as their characteristic is currently not well defined due to the lack of data. Raw wastewater originates from domestic and industrial sources. The characteristics of wastewater are affected by water consumption rates, population density, industrial practices and habits of population. Four Wades in the West Bank carry wastewater all over the year during the summer and winter seasons, and considered as pollutant carrier that mixed with rain water, are Wade of Al-Nar (Eastern aquifer), Wade Al-Fara' (North Eastern Aquifer), Wade Al-Zumar (western aquifer), and Wade Qana (western aquifer).

The groundwater contamination disposal of wastewater will result in the direct contamination of springs. Moreover, the flow of raw wastewater into open areas will negatively affect the soil cover and plants in addition to direct health hazard. Additional problems connected to existing discharges also include odour and aesthetic problems.

The discharge of raw wastewater without any treatment causes a major potential health hazard as it carries disease in the form of pathogens and toxic elements. When wastewater is disposed in the environment (mainly in wet season) or in the cesspits, it may be mixed with surface water, infiltrated into the underlying layers and finally may contaminate groundwater. Contamination of groundwater may occur by one of three mechanisms; infiltration recharge from surface water, direct migration and inter–aquifer exchange. Shallow aquifers, like the north eastern and the northern part of the western aquifers may be affected by the first and second mechanisms, while the third mechanism may affect both shallow and deep aquifers, like the western and eastern aquifers.

The effect of solid-waste causes through dissolution of solid waste combined with rainfall and produce large quantity of polluted water in the form of leachate. Tons of solid wastes are generated

daily in West Bank and most of it ends up in open dumpsites. Solid waste problem in West Bank is especially grave as a result of three main reasons; population growth rate, rising of living and consumption patterns. This situation results in an increase in the number of dumpsites to reach around 89 dumpsites (Al-Hamaidi, 1993). Because of heterogeneous nature of wastes and variations in aquifer properties, landfill sites represent a challenging opportunity to try and understand the transport and fate of waste-derived contaminants (Abu-Rukah & Al-Kofahi, 2001).

The major heavy metals found in leachate included Pb, Fe, Mn, Cd , Ni and Zn while the organic compound were aromatic hydrocarbons (mainly xylenes), phenols and pesticides (kjeldsen,1992). Toxic materials and pathogenic organisms may end in ground or surface water as a result of the movement of leachate from landfills.

2. PROBLEM DEFINITION

The effect of hydrochemical changes of the water quality allocation sources in the West Bank should put threats to the groundwater as well as surface water sources against natural and man made pollution. The qualitative changes will help to address the hydrochemical changes in order to build a related decision support system. These qualitative analyses should have the benefit for the maximized hygienic water for the people both quantitatively and qualitatively manners and preserving the ecosystem in the area. The present study aims to assess the negative impacts of pollutants of solid waste dumpsites and the liquid wastes in some selected areas on the quality of groundwater, especially the springs. This is accomplished by selecting several wells around the dumpsites and wastewater wade discharge and testing their physical, chemical and biological characteristics. This study is important to reduce environmental pollutant discharge as well as to improve water quality and resources sustainability.

3. BACKGROUND ABOUT THE STUDY AREA

A series of aquifers and aquicludes in the West Bank are as follows: Kurnub (Kurnov) group aquiclude, Ajlun series (Judean group) aquifer, Belqa series (Mount Scoupes group) aquiclude, Jenin sub-series aquifer to aquitard and Beide and Lisan aquifer. The aquifer system in the West Bank is heterogeneous and its parameters are varying from point to point (Tahal, 1966). The aquifer system includes one upper phreatic and two lower confined aquifer systems. Groundwater is found in formations of Pleistocene to lower Cenomanian age, at depth ranging from several hundred of meters to many meters. In the area under investigation, five sub-aquifers are located within unconfined and confined strata. These aquifers are the unconfined Pleistocene, Neogene and Eocene and the confined upper and lower Cenomanian sub-aquifers. Two main structural folds are dominant in the study area, the Anabta anticline and Nablus-Beit Qad syncline. Most of the faults trend east west with some faults trending northwest southeast. Joints and karstic caves are well developed in the Bethlehem, Hebron and Jerusalem formations.

The West Bank aquifers, especially the western is considered to be sensitive from the hydrological point of view. This originates from the direct recharge of the rainfall to the groundwater. The outcroppings rocks are of sedimentary rocks and composed of limestone, dolomite as well as thin laminations of marl and chalky limestone. The whole area is semi karstified and of direct effluent to the groundwater bellow. The infiltration rate is higher than other areas in the West Bank and reaches in some places 26% of the rainfall.

The natural outlet of the groundwater in the West Bank is the springs that are spread inside the villages and the surroundings. More than 300 springs are recognized in the West Bank. The majority of these springs are suffering from the leakage of the cesspits, which are spreading in the whole area considering the major sewage system there in the absence of systematic sewage system with treatment facilities. Those springs are polluted to some extent from these cesspits in the area. This pollution is considered to be dangerous from the health point of view, in the reason that these springs are used for drinking and agricultural purposes. Water Pollution cause diseases for the inhabitants in the area.

4. METODOLOGY

Field work and water sampling campaign was done during the last five years through different Palestinian institutions, among these are the Palestinian Water Authority, Universities and the Palestinian Hydrology Group in order to have imprints about the groundwater quality changes. Historical data from different governmental and none governmental sources are available in the period of twenty years.

The physical parameters such as temperature, pH, electrical conductivity (EC), total hardness (TH), and total dissolved solids (TDS) were measured, while the chemical parameters contain major cations (Ca2+, Mg2+, K+, Na+), major anions (HCO3-, NO3-, Cl-, SO42-), major ions (PO43-) and heavy metals (Pb, Fe, Mn, Cd, Zn, Al, Ba,….) were analysed. In some samples BOD, COD, TSS and Total and Fecal coliforms are analysed.

5. DISCUSSION AND RESULTS

The Human activities cause pollution to the groundwater through the followings: Discharge of inadequately treated effluent municipal treatment plants, Discharge of untreated domestic and agricultural wastes, Discharge of untreated domestic and agricultural wastes, Extraction, use, and disposal of poor - quality ground water, Leach ate from solid waste landfills, Runoff from urban drainage, Fertilizer and pesticide residues and Drainage of wetlands. Due to the uncontrolled waste disposal patterns in the West Bank as a whole, some levels of the contaminants were found in groundwater. The level of trace metals in groundwater depends on the ion exchange capacity of the soil layer that will attenuate the down gradient movement. But the level of organic matter in groundwater depends on the organic content of the soil and biodegradation rate. Natural filtration through geological formations will affect the presence of trace metals, organic matter and the physical parameters such as TDS, EC, pH, temperature and total hardness.

In Nablus city it self, the network covers 70% of households. The remaining part of the population uses cesspits. The western sewerage pipeline, within the municipal boundaries, discharges into Wadi Nablus, as does the wastewater from several villages located close to Nablus. The present pipeline discharges into Wadi Al-Sajoor, from where sewage flows through Wadi El Badan and into the Jordan valley. In this way, wastewater either pollutes the aquifer through percolation or is used by farmers for irrigation. Wastewater in Tulkarm district is either collected and discharges into Wades or temporarily stored in cesspits prior to dumping (ARIJ, 2002). A survey carried out by ARIJ in 1996 showed that 70% of the population depends on cesspits for wastewater disposal and only 30% benefit from connection to a sewerage system, and that these only exist within the borders of Tulkarem municipalities and refugee camps. Only 50% of the wastewater in Qalqilia flows into the stabilization ponds operated by the municipalities; the other half flows western. The leakage of wastewater from the sewerage networks in both Tulkarem and Qalqilia reaches 50% (Arij, 2002).

6. EFFECT OF PESTICIDES AND FERTILIZERS

Pesticides are applied rather generously in the West Bank; for example, 15,000 metric tons are applied every year in Israel and the West Bank. Pesticides are also transported by runoff affecting aquatic ecosystems. The total quantity of pesticide used is estimated at 730 tons in the West Bank (ARIJ, 2003). In the West Bank, the pesticides are used intensively in the irrigated agricultural areas, for example in the Jordan valley, north of the West Bank and Gaza Strip. The agricultural sector uses of pesticide have increased by using green house in which they use 372 tones per year from the disinfecting gas like Methyl Bromide. It is important to emphasize that this is halide organic compound and widely used.

Fertilizers are applied in large quantities in the West Bank, often in the irrigation water. Fertilizers reach aquatic ecosystems, where they can cause eutrophication, and they also contaminate ground water. Thus, water drawn from Wades and aquifers for agriculture contaminates and alters ecosystem functioning. Again, such indirect effects of water use may be environmentally more significant than their direct effects.

7. VOLATILE AND SEMIVOLATILE ORGANIC COMPOUNDS IN NATOV CATCHMET

Some springs in the Natuf drainage area, which is located in the Western aquifer and to the west of Ramallah city in the West Bank in Palestine, has been found to contain traces of Volatile Organic Compounds (VOC), and larger amounts of Semi-Volatile Organic Compounds (SVOC). Since VOC are easily removed by good aeration and the concentrations of VOC found from the analysis of spring's water were less than 2 mg/L, which proves that these springs are located in shallow perched aquifers and are well aerated. SVOC concentrations in groundwater depend on the compound type, site-specific geology, hydrology and anthropogenic factors. SVOC are originated mainly from excessive use of pesticides, herbicides and from petroleum products. They are hardly degradable species and can remain attached to soil particles for longer time, which means that their concentration is accumulative. The fact that many kinds of pesticides and herbicides are being used by farmers in the area for grapes, figs and even for olive fields. Such compounds are toxic to mankind, cattle and affects quality of groundwater in the area. The variation of concentration of SVOC from one spring to another and from one year to another can be related to hydrological and anthropogenic factors only. It can be noticed that the concentration of Alkanes, Alkenes, Cycloalkanes and cycloalkenes has increased from 129ppm as an accumulative value in the year 1999 to a value of 316ppm in the year 2000.

8. HYDROCHEMICAL ASSESSMENT OF NATOV CATCHMENT SPRINGS

The water spring samples of Ein El Maasal, Ein Qinia, Ein Harasha, Ein El Balad – Surda, Ein Arik, Ein Mutzbah, Ein Um Aisha and Ein Shik Yousef were analyzed hydrochemically in wet and dry seasons for the year 1999/2000. The analyzed spring reveals of Ca-HCO3 type, Ca-Mg-HCO3 type in wet and dry seasons, respectively. All of them reveal of no pollution. The trace elements of Si, Cd, Sr, B, Zn, Mo, P, Cu, Fe, Ni, Pb, Ag, V, Cr and Mn reveal that the springs are enriched with S and Si. The average of S and Si is 10 and 4 mg/L, respectively. Sulfer shows its maximum limit at the Ein Mutzbah (20 mg/L), while the silicon shows its maximum limit at Ein Massal. Ein Mutzbah shows a high concentration of NO3 and SO4 due to the nearby cesspits that are of direct affect to the spring. Two spring cases of a non-contaminated spring Ein Areek and a contaminated spring Ein Mutzbah were reported. The Hydrochemical parameters of Ca as well as Mg in Ein Misbah spring show an increasing trend, while the other parameters show a decreasing trend from the start of winter to its end.

9. SPRING WATER QUALITY IN HEBRON

Thirty water spring samples were analysed hydrochemically for the Beit Ula springs / western Hebron reveals that the two springs of Mohammad Yousef and Sharawi showed high concentration of Nitrates (62 mg/L). The EC of these two springs are 1077 and 1137 micro Semins/cm, respectively. The two springs showed also too numerous to be counted from total and fecal coliforms. This is due to the infiltrated nearby cesspits to those springs in the area, the high pH (8.5) enrich this wastewater cesspits pollution results. Another two springs (Al Far and Fawzi Al Adam)showed a high concentration of chloride, 248 and 277 mg/L and sulphate (55 and 64 mg/L), respectively. This is due to the agricultural activities of the fertilizers that are used by the farmers in the agricultural fields nearby those springs.

10. TREATED WASTEWATER ANALYSIS IN RAMALLAH

Treated wastewater samples in the year 2000 were analyzed for major ions from the wastewater flow outlet in Beitunia area near Ramallah. The wastewater type reveals of Na-Cl type. The average of NO3 is found to be 64 mg/L, which is considered to be good treated wastewater to be recharged within the catchment.

11. WATER QUALITY IMPLICATIONS FOR WATER MANAGEMENT

Concentrations of all major ions are below drinking water standards and the EC and pH values are indicative of generally good quality water. This is confirmed by the analytical results of trace elements and organic compounds. It should be noted that the most springs around Ramallah, sampled and analyzed during 1999 - 2004 were found to discharge pristine drinkable water. Two exceptions of the springs of Ein Mutzbah and Surda showed elevated NO_3, attributed to the animal manure (sheep herds of local farmers) or human waste. In addition a gasoline by-product was detected in trace concentrations in most springs, suggesting rapid recharge of groundwater by surface water flushing the roads. Higher nitrate concentrations were limited to the station draining the industrial area, but were below drinking water levels.

Urban runoff pollution results from numerous sources including rainfall that becomes contaminated as it travels through the atmosphere, along the land surface, and makes its way to a water body. Since urban runoff, which enters water bodies from diffuse or unidentifiable locations and sources, can cause significant water quality degradation, it certainly should be addressed as part of a municipality's overall urban runoff pollution prevention and control program that present unique challenges. Land development and intensive land use lead directly to many of the pollution problems associated with urban runoff. These problems can be divided into two basic categories: hydrologic impact of urbanization and urban runoff pollution.

Realizing that the western Catchments strongly control the water quality of their draining rivers, recent discussions on new water quality measures include the characteristics of the contributing Catchments. Industrial, urban and agricultural pollution has led to the accumulation of contaminants in sediments, plants, and groundwater reservoirs. In general short residence times in karstified aquifers result in a limited ability of self-purification. The aquifer below Ramallah is composed of karstified limestone and dolomite, and as such is highly vulnerable to contaminant migration from land surface through preferential flow paths. The fast increase in Palestinian urban areas located on top of the recharge zones of the aquifer is bound to increase surface flow at the expense of groundwater recharge. This is due to paving and soil compaction, deteriorate surface water quality, affect groundwater quality by direct pollutant release into the ground (leaky pipes, cesspits) or to surface drainage systems from which contaminated runoff may eventually percolate.

12. EVALUATION EFFECTS OF GROUNDWATER QUALITYY

The concentration of nitrate, sulphate, and chloride are increasing dramatically in the majority of the contaminated springs. At many locations of observation wells, the content is beyond limits, which are given for the use as drinking water standards by the WHO. It was found that the content of the given compounds in the seepage water approaching groundwater is by far higher than in the groundwater. Especially the nitrate content increases exponentially between 1970 and 2004. The rise of the concentration in groundwater will continue. Mostly sewage water from households and industry contributes to the phenomenon of high nitrate contents. Seepage water from all kinds of waste disposals should be the most important source for sulphate and chloride. A certain quantity of the given chemicals originates from agricultural activities.

13. CONCLUSIONS

- The groundwater quality in the West Bank show changes, due not only to the natural processes, but to man made pollution processes.
- The shallow aquifers in the West Bank are facing the groundwater contamination more than the deep aquifers.
- The groundwater polluted sources in the West Bank are the wastewater municipal treated or raw discharge, discharge of untreated domestic and agricultural wastes, discharge of untreated domestic and agricultural wastes, disposal of poor - quality ground water, Leach ate from solid waste landfills, Runoff and cesspits, especially in the rural communities.
- Many springs distributed all over the West Bank are polluted from the cesspits in the rural communities.
- A demand pressure could be caused on the future demand for the available water resources in

the West Bank in regard to the increase deterioration the aquifers in the West Bank.

14. RECOMMENDATIONS

- Leachate analysis should be conducted to understand its effect to the groundwater quality.
- Soil sampling and analysis should be conducted to determine the effect of the soil components to the groundwater.
- Public Awareness campaign for the people and the well should be suggested for the area to be aware of the liquid and solid disposal wastes.
- Hydrogeochemical model should be recommended for the future monitoring of the water spring quality. The quality relation of the Rainfall-Runoff ratios should follow this model.
- The east – west water quality profile of rainfall as well as runoff is recommended. The quality relation parameters between the catchments are recommended.

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