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Treatment Technologies Needs for Water in the West Bank Groundwater Aquifers

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Abstract

The water quality degradation in the Eastern, North Eastern and Western aquifers characterized as high salinity and nitrate contents respectively renders to their potentiality for both domestic and agricultural utilization. In addition to the limited access of the Palestinians to the available water resources due to the Israeli political restrictions and mismanagement, annual deterioration of aquifers water quality exacerbates the water shortage problems. Despite the huge financial expenditures made by the Palestinian Water Authority on water quality monitoring and pollution modeling, about 250 Palestinian communities still lack drinking water networks and use different types of sources mainly springs for drinking which in general polluted with biologically and chemical parameters, hence; little efforts were made on water treatment for domestic purposes. Since; annual increment of nitrate content in drinking water supplies in Palestine imposes potential public health risks if not properly treated. Provision of a sustainable safe and biologically stable drinking water to the Palestinian communities requires for an urgent investment in technically adequate and economically feasible water treatment technologies.

Keyword: Desalination, Denitrification, Water purification, Western, Eastern , Northeastern Basin.

Introduction

Water sacristy in West Bank makes it's availability of to be as a high value. In addition to the natural local recourses, which considered to be poor, water treatments could contribute in solving the crises in the region. Water deterioration in Western aquifer affects the whole region, since the pollution of the ground water is a cross-boarder issue, then no area will be vulnerable from the infection. The solution of this environmental problem may help to decrease Palestinian suffering and avoid farther crisis within this environmental issue. Since; Qalqilia, Tulkarem, Jenin considered the main agricultural areas in the West Bank, which plays a major role in the Palestinian national gross income area located over the Western aquifer, which shared between Israelis and Palestinians. The water treatment technology should apply in the region of the western aquifer, hence; the intensive cultivation, wastewater disposal without any type of treatment, arbitrary dumping site for solid waste:- Nitrate and Potassium, Fecal coliform, Traces and organic material concentration were measured and found to be higher that the accepted values. This problem is intensified with the uncontrolled use of pesticides, herbicides and traces that could easily

penetrate as leachate into the ground water that provides West Bank inhabitants with potable water.

One of the innovative solutions for the problem could be a technology in which Nitrate, Potassium, organic pollutants and biological indicators that could be eliminated over two stages. In the first stage, Nitrates and Potassium could be eliminated by means of ion exchange method. The second stage could be implemented in which the toxic halogenated organics could be oxidized into harmless compounds such as carbon dioxide, water and Chloric acid. This applied technology has a major advantage over other sophisticated methods that it reduces the cost of treatment to the minimal in addition to that it uses local available technology utilizing the great amount of solar energy available over the years.

Objectives

- Reviews the water quality of Eastern, North Eastern and Western aquifers.
- Identify the major water pollutants and health impacts associated.
- Identify the pollution sources are presented and possible pollution control strategies are suggested.
- Adequate recommended technologies for treatment including the biological denitrification of nitrates rich groundwater and desalination of brackish water are discussed and evaluated with emphasis on technology and economical aspects to have potable water with good quality.
- To raise the awareness and addressing important public health aspects through understanding the fortune and survival of purified water

Water quality in the West Bank

Groundwater quality in the West Bank change in both horizontal and vertical directions. The fresh groundwater are not distributed evenly throughout the whole of the West Bank Chloride concentration is ranging between 25ppm to 500ppm in domestic well. Nitrate concentration is generally ranging between 15ppm to 111ppm all over the area even that contain fresh water, and potassium, Fecal coliform range 4-33ppm and 0-TMTC CFU/100 ml respectively. Pesticides and herbicides are normally found in agricultural areas and are associated with high Nitrate.

High salinity and high nitrate concentration levels in groundwater are attributed to the following reasons:

- Deep brackish water upcoming resulting from high groundwater abstraction.
- Infiltration of raw wastewater in the un sewered areas.
- Leaching of fertilizers and pesticides through infiltration and rainwater.

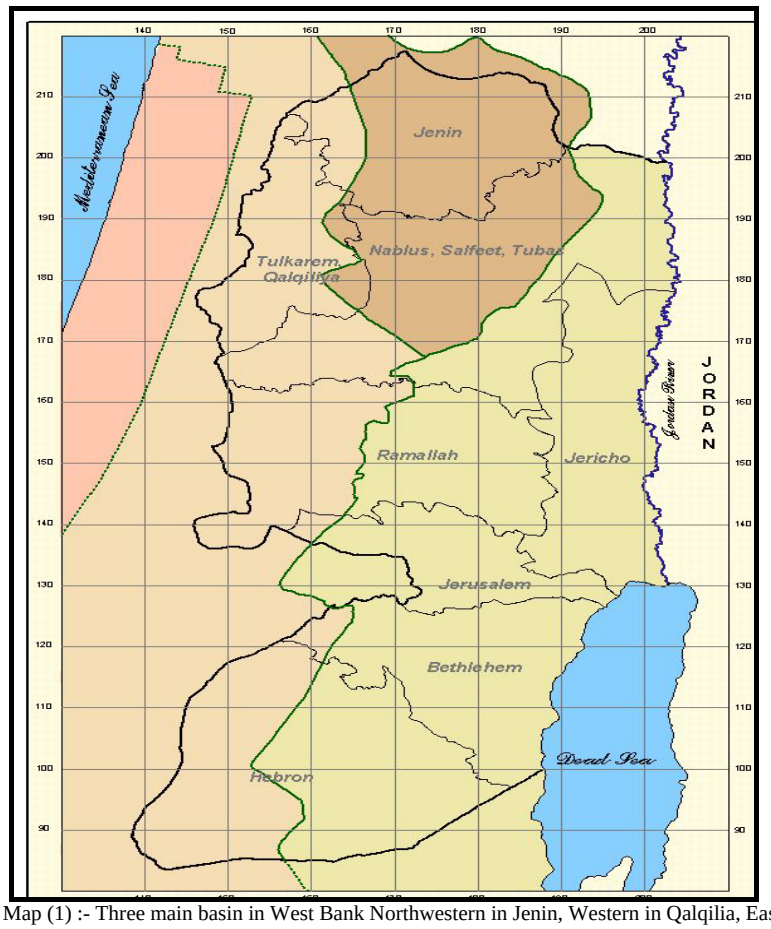
In the West Bank there are three main basins Map (1) distributed and characterized according to Palestinian Water Authority (PWA, 2006) as follow :-

- Eastern basins: south of Hebron to North of Ramallah and Jordan valley, in which their 102 agricultural and domestic wells.

- North Eastern basin: Nablus and Jenin area, in which 111 agricultural and domestic wells.
- Western basin: Tulkarem, Qalqilia, and West of Hebron, in which 117 agricultural and domestic wells.

Water quality for wells and spring in the West Bank area according to analysis done in the central laboratory of Palestinian Water Authority during 1997-2006, since; the results for sources that used for domestic purposes from Wells and spring in the West Bank can be summarized and classified according to the main three basin in the following Tables (1,2,3).

The chemical characteristic of the Western and Northeastern aquifers mainly in the upper aquifer are similar to those of the lower aquifer, since; They characterized by Calcium-Bicarbonate water although the water-bearing formations are richer in dolomite rocks, this does not appear on these particular water analysis since Magnesium content stays very similar to the values it showed in lower aquifer waters, and their incremental increase in Nitrate, potassium, Fecal coliform Table (1) , (2).



Map (1) :- Three main basin in West Bank Northwestern in Jenin, Western in Qalqilia, Eastern in Jericho.

Table (1): Water quality analysis for North eastern basin in Jenin area as a range values from sources used for domestic purposes (PWA, 2006).

Parameter	Results
NO_3^-	2-110ppm
Na^+	43-105ppm
Cl^-	80-700ppm
Mg^{+2}	15-75ppm
Ca^{+2}	75-200ppm
TDS	600-2300ppm
Fecal coliform CFU/100ml	0-TMTC*
Total coliform CFU/100ml	0-TMTC

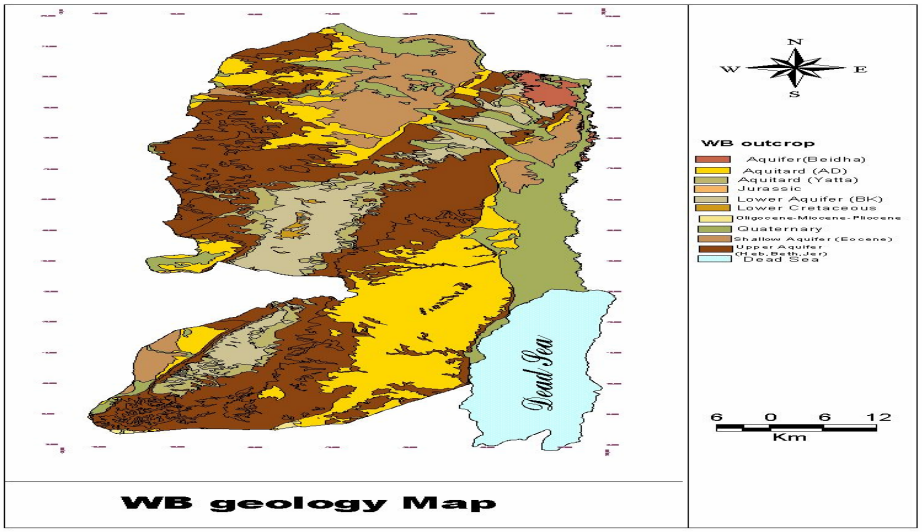
Table (2): Water quality analysis for Western basin in Qalqilia and Tulkarem area as a range values from sources used for domestic purposes (PWA, 2006).

Parameter	Results
NO_3^-	12-130ppm
Na^+	20-75ppm
Cl^-	40-300ppm
Mg^{+2}	22-85ppm
Ca^{+2}	30-125ppm
TDS	200-1800ppm
Fecal coliform CFU/100ml	0-TMTC
Total coliform CFU/100ml	0-TMTC

The salinity in the Eastern aquifer water quality due to both deeper aquifer through fracturated zones, and from the Pleistocene aquifer which gets its salinity from evaporate layers according to Geological Map (2) of West Bank and result summarized in Table (3). Moreover; the Israelis have succeeded to tap fresh water in a few wells close to the rift fault. However, no heavy metals, or pesticides were done in routine analysis in the West Bank.

Table (3): Water quality analysis for Eastern basin in Jericho and Jordan Valley area as a range values from sources used for domestic purposes (PWA, 2006).

Parameter	Results
NO_3^-	12-130ppm
Na^+	20-875ppm
Cl^-	40-3300ppm
Mg^{+2}	22-285ppm
Ca^{+2}	30-825ppm
TDS	290-5800ppm
Fecal coliform CFU/100ml	0-TMTC
Total coliform CFU/100ml	0-TMTC



Map (2) Geological map for the West Bank

Water discharge from aquifer in West Bank

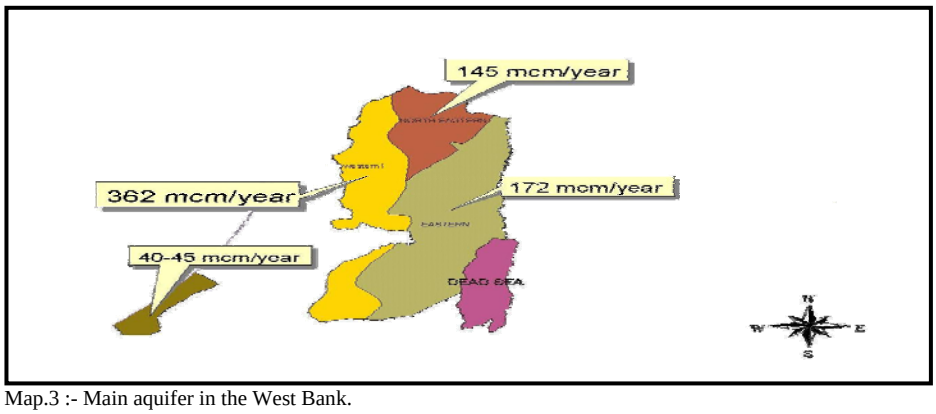
The total amount can discharged according to the Oslo B agreement are also and compare it during the 1990s that can be presented in Table 1.

Table 1. Annual use groundwater from the Mountain Aquifer (MCM/ yr)

Basin	Annual Replenishment	Water Use during the 1990s [3]			Interim (Oslo B) Agreement on Freshwater Allocations		
		Israeli	Palestinian	Total	Israeli	Palestinian	Total
Western	350-360	300-	20-25	320-455	340	22	362
Norther	140-150	100-	45	145-155	103	42	145
Eastern	150 (180)	40	42	95	40	54	172[5]
Total	640-660 [2]	440-	116-121	460-705	483	118	679[5]

[1] Different from the exploitable potential.
[2] Regardless of the higher estimate in the eastern basin.
[3] Including unused spring flows.
[4] From Article 40 of the Oslo B Agreement, 1995.
[5] Including additional 78 MCM/yr proposed for extraction.

Overall, Palestinian in the West Bank use of the aquifer water (Map.3) in the 2005 is estimated at approximately 120-135 MCM/yr for domestic and agricultural activity, compared with 480-590MCM/yr used by Israel.



Map.3 :- Main aquifer in the West Bank.

Technical background

Drinking water has not treated except by chlorination in municipal directorate which represent about 90% of the West Bank areas. Chlorination process done without any control with its residue or interaction between residue chlorine and organic material in the domestic water in the network or tanks, other pollutants, which as a results from fertilizers or wastewater is Nitrate, potassium, Fecal coliform which varied in the groundwater Western, Northeastern and Eastern basins (domestic and agricultural wells). The incremental in concentrations of Potassium, Nitrate, Chloride and Fecal coliform were above the recommended limit by WHO, 1998 which (10ppm K, 45ppm NO3, 200ppm Chloride and 0 CFU/100ml Fecal coliform). The concentrations incremental are due to the intensive use of fertilizers, wastewater discharge, high sensitive area where wells in depth were about 50-75m and the concentration increase due to over pumping from the used wells (World Bank, 1993).

The recommended method for the Western basin by which nitrate, organic material can be removed and reduction of pathogens in the drinking water by Advanced Oxidation Processes (AOP) based on initiation of OH–radicals, which can oxidize a high variety of contaminants in polluted water. The main advantage of this technology is the capability to eliminate the pollutants and convert them into harmless compounds such carbon dioxide, water and halogens. In comparison to the conventional water treatment, such as the membrane separation technology or the adsorption of the pollutants onto the surface of activated carbon, which must be retreated after the treatment process, AOPs considered to be as an economical alternative. There are many ways to initiate OH- radicals; most of these ways are based on irradiation of catalysts and other chemicals like titanium dioxide and hydrogen peroxide. The use of solar light, as a source of energy, constitutes an economical advantage.

The recommended method for Eastern basin to remove the high concentration of Chloride and Sodium were Reverse Osmosis (RO) by which the overall amount of the Total Dissolved Solid reduced to be suitable for drinking, about 35% of the community in the Jordan valley drink water in which TDS > 1500ppm. According to the study done by the Palestinian Water Authority (PWA, 2005) in which the Chloride and Nitrate increase by 4ppm and 3ppm respectively in about 30% of the studied sources.

Both method not applied till now, since; water deterioration enforces the design makers and authority responsible for water management to alternatives for domestic water so a lot of study needed in term of socioeconomic and consumers acceptance to use the treated water after use a pilot study for the recommended method for water treatment.

Evaluation of agriculture activity in the West Bank

The use of extremely toxic pesticides that are banded or restricted in many countries by the World Health Organization (WHO) has been highlighted as well. For example, 14 types in the West Bank. The effect of pesticide varied by direct effect of acute toxic on the farmer and their family, or toxic if it is transferred by the crop to the consumer with high concentration regardless to the limitation of use. Since, the absence of health surveillance, monitoring system, absence of legislation and control system has result in lack of awareness among farmer and the public. So farmers use pesticides excessively without being aware of their hazards to their own health, or to the consumers and the environment (ARIJ, 1995) . The problem is not limited to the West Bank, and has afflicted all of the neighboring countries. Much effort has recently been expended to find alternatives to non biodegradable pesticides.

Crop variation and specificity of the product for each area cause variation in pesticide use in the West Bank. In which large amount of sulfur type of pesticide for grapes (50 ton per year consumed in Hebron) and 200 ton from Methyl Bromide used in Plastic Houses in Tulkarem, Jenin, Jericho and Jordan valley (ARIJ, 1994). Total amount of pesticide used in the West Bank (including Methyl Bromide) is 494 ton per year. From which 12%in Jenin, 20% in Tulkarem, 6%in Nablus, 24% in Hebron, 9%in Ramallah and 29% In Jericho, this percent is excluded methyl bromide (ARIJ, 1994).

Expected benefits and conclusions

- Scientific research for safely treated infected water would help in finding solutions to maximize existing resources, improve regional water resources.
- Educational institutions will introduce a new unconventional water treatment technology to the (universities, research centers and other stockholders) in the Palestinian regions.
- Decrease water scarcity and to have alternatives as non-conventional water sources in the West Bank.

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معالجة المياه الجوفية في الضفة الغربية للأغراض المترلية

صبحـــي سمحـــان

سلطة المياه الفلسطينية – فلســـطين

إن التدهور في نوعية المياه في الأحواض الجوفية (الغربي، الشرقي، والشمالي الشرقي) في الضفة الغربيـــة مـــن حيث ارتفاع في عناصر الملوحة والنيترات يرجع إلي عدم معالجة مياه المجاري والاستخدامات الزراعيـــة ومخلفاتهـــا ممـــا يسبب تدهور في البيئة المحيطة وبالتالي المياه الجوفية. ومن أهم الأسباب التي تجبر الفلسطينيين على تركيـــز الزراعـــة في مناطق واحدة وعدم معالجة المياه العادمة هي سياسية في الدرجة الاولى تتلخص في جدار العنـــصري الـــذي اســـتترف الأراضي، منع الفلسطينيين (من قبل الإسرائيليين) من سحب ما هو مسموح لهم من المياه الجوفية من أراضـــي الـــضفة الغربية، وضع قيود تعسفية على إقامة محطات للمعالجة المياه العادمة، وحذر حفر أبار للاستخراج الميـــاه الجوفيـــة مـــن الطبقات العميقة وحصر الفلسطينيين من السحب فقط من الطبقات السطحية مع مراقبة وبـــشكل دوري مـــن قبـــل الإسرائيليين لذلك. كل ما ذكر يؤدي إلي حدوث أخطاء وأضرار في إدارة قطاع المياه من حيث الـــسوء في التوزيـــع وتلوث على البيئة المحيطة ونص حاد في المياه. إن التدهور في نوعية المياه المستخدمة للاستهلاك المترلي والنقص الحـــاد في توفير المياه ذات النوعية الجيدة سيما وأن هنالك ما يقارب 250 تجمع لا تزال غير موصولة بالمياه (وتستخدم معظمهـــا مياه ملوثة) ويرجع ذلك إلي عدم توفر المصـــدر او عدم وجود شبكة او الاثنين معاً. إن معظم هذه التجمعات تستخدم مياه الينابيع والتي تعتبر سطحية وتكون ذات حساسية عالية وهي ملوثة بيولوجياً (بكتيرياً) وتعاني أيضاً من ارتفـــاع في تركيز النيترات والملوحة. وبالنسبة لمعالجة المياه المستخدمة للاستهلاك المترلي فأنه لا توجد أي جهود تذكر بسبب نقص الخبرة، الإمكانيات، وعدم وجود الأبحاث التي يمكن اعتمادها لتكون على مستوى وطني، لذا فأن هذه الورقة ســـتعرض نوعية المياه في الأحواض الجوفية في الضفة الغربية لتحديد اولاً: الملوثات الرئيسية وتأثيراتها الصحية، ثانياً: مصادر هـــذه الملوثات مع اقتراح استراتيجيات للحد من هذه الملوثات وأخيراً، وحتى نتوصل إلي الطرق المثلى المستخدمة في معالجـــة المياه والتركيز على المياه التي تعاني من ارتفاع في تركيز النيترات والملوحة والملوثات البيولوجية (بكتيرياً) وكذلك هـــل من الممكن لسلطة المياه أن تتبني مثل هذه المعالجات المطروحة بحيث تكـــون مجديـــة اقتـــصاديا ومناســـبة للتجمعـــات الفلسطينية.