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Thesis Approval

Quantifying and qualifying the brackish ground water

In Jericho area / West Bank

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Abstract:

Water sources in Jericho area are limited to spring water and boreholes ground water, fresh water drain from the Mountain Aquifer and the Plio-Pleistocene aquifer system.

Increasing water demands for both agricultural and domestic sector lead to increase pressure on the Plio-Pleistocene aquifer.

Rising of salinity and lowering water table are major problems facing the development of agricultural sector. Brackish water become the common water sources in the study area.

The major objective of this study is to identify the major salinity zones in term of quantity and quality. To carry this task forty four ground water samples are collected and analyzed during the period 2010-2011. Major cation and major anions in addition to B, Br, Ba, Si, Sr, TOC, pH, Ec were analyzed, ARC GIS 9.2, AQUA-Chem. 3.2 and office package software programs used for the interpretation of the data.

The total volume of tapped brackish water can divided to 8.6 MCM/a with Ec more than 1 mS/cm. Three major salinity zones were identified in four locations; these are zone I between 3-6 mS/cm, Zone II between 3 - 5 mS/cm, zone III between 2 - 4 mS/cm and zone IV between 1-4 mS/cm.

Two major source of water are identified which are: water flow from the Mountain aquifer system and old brine within the Plio-Pleistocene aquifer system, the first source water flow through certain windows along the N-S-major fault system, and up coning of saline brines due to the over pumping.

Four water types identified in ground water samples these are Na- Mg-Cl type which is the major one (86% of the sample), and Na-Cl, and Mg- Na-Cl type and Na-Ca-Cl.

During the last 20 years the average water salinity increase from 1.5 to 4.5 mS/cm, and the borehole production decrease from 10 MCM/a decrease to 8.5 MCM/a.

Classification of ground water sample based on salinity hazard identified that 100% of the samples are unsuitable for irrigation, and based on total hardness 93.2 % classified as very hard, based on sodium hazard % Na 79.54 % of samples classified as unsuitable for irrigation

and for SAR 72.7% of the sample are excellent and 2.3% are unsuitable for irrigation, classification based on bicarbonate hazard 90.9% of the sample are good and 4.55% of the sample are unsuitable for irrigation.

These results indicate that Jericho is facing two major problems mainly continues decrease of water production and continues increase of salinity. Both obstacles cause limitation of using water in irrigation of vegetables and force farmers to introduce date trees, where the number of date trees in Jericho area rise more one thousand trees. The average yearly consumption of one date tree is not less than 100 CM/a, this will cause additional presser on Plio-Pleistocene aquifer system. Desalination of brackish water is the only solution to overcome the salinity problem.

كمية ونوعية المياه الجوفية المتملحة في منطقة أريحا / الضفة الغربية

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الملخص:

قطاع المياه في منطقة أريحا يعاني من محدودية المصادر، حيث إنها مرتبطة فقط بكميات المياه المتدفقة من مجموعة الينابيع في منطقة أريحا، وكميات المياه العذبة المستخرجة من الخزان الجوفي الجبلي، بالإضافة إلى المياه المتملحة المستخرجة من الخزان الجوفي الضحل.

زيادة الطلب على كميات المياه لكل من القطاع الزراعي والاستخدام البشري اليومي في منطقة أريحا والأغوار أدى إلى زيادة معدل كميات المياه المستخرجة من الخزان الجوفي الضحل، مما أدى إلى زيادة الضغط على هذا الخزان، مما أدى إلى ارتفاع نسبة الملوحة في المياه الجوفية وانخفاض مستوى سطح الماء الساكن في الآبار الجوفية.

ارتفاع نسبة الأملاح الذائبة في المياه المستخرجة من الآبار الجوفية في منطقة أريحا بالإضافة لانخفاض في مستوى سطح المياه في الآبار الجوفية من أهم المشاكل التي يواجهها القطاع الزراعي في محافظة أريحا مما سوف يجعل من المياه المتملحة مصدرا يزود القطاع الزراعي باحتياجاته بعد استخدام تقنيات معالجة المياه المتملحة وأهمها عملية التحلية.

ضمن هذه الدراسة تم جمع أربعة وأربعون عينة من مياه الآبار الجوفية في مدينة أريحا خلال الفترة الزمنية الواقعة بين عام 2010 - 2011 وخضعت هذه العينات إلى عدة تحاليل كيميائية وهي العناصر الموجبة والعناصر السالبة بالإضافة إلى تحاليل عناصر B, Br, Ba, Si, Sr, TOC بالإضافة لقياس الرقم الهيدروجيني والموصلية الكهربائية للمياه.

اعتمادا على الموصلية الكهربائية لمياه الآبار بالمليسيمنز / سم تم حساب كميات المياه المتملحة للآبار التي تم جمع عينات منها وقدرت بـ 8.6 مليون متر مكعب سنويا للآبار التي زادت فيها نسبة الموصلية الكهربائية عن 1 مليسيمنز / سم، تم تحديد ثلاثة نسب للمياه المتملحة في أريحا في أربعة مواقع وهي منطقة I وبلغت نسبة الموصلية الكهربائية 1-3 مليسيمنز / سم، ومنطقة II وبلغت نسبة الموصلية الكهربائية 3-5 مليسيمنز / سم و منطقتي V, III حيث بلغت نسبة الموصلية 2-5 مليسيمنز / سم.

تم تحديد مصدرين لتغذية المياه وهي المياه من الخزان الجوفي الجبلي حيث أنها تتدفق من خلال عدة منافذ من الشمال باتجاه الجنوب بالإضافة إلى المياه شديدة الملوحة الموجودة في خزان المياه الضحل حيث إنها تتدفق نتيجة الضخ الزائد من الخزان الضحل .

اعتمادا على التحاليل الكيميائية وبعد معالجة النتائج باستخدام برنامج 3.2 AQUA-CHEM تم تعريف أربعة أنواع للمياه (Na-Mg-Cl) وبلغت نسبتها 86.4% من العينات: و (Mg-Na-Cl) و (Na-Ca-Cl) و (Na-Cl).

ارتفعت معدلات الاملاح في المياه المستخرجة من الآبار خلال العشر سنوات الماضية من 1.5 مليسيميتر /سم الى 4.5 مليسيميتر /سم وانخفضت معدلات الإنتاج من 10 مليون متر مكعب إلى 8.5 مليون متر مكعب .

تم تصنيف عينات المياه بناء البيانات التي نتجت عن معالجة النتائج من حيث استخدامها في القطاع الزراعي حيث تبين أن 100 % من مياه عينات الآبار هي مياه غير صالحة للاستخدام الزراعي نظرا لارتفاع نسبة الاملاح فيها وبعد حساب المعامل عسورة المياه (Total hardness) تبين ان 93.2 % من المياه صنفت بانها سيئة جدا للاستخدام الزراعي بينما صنفت العينات من ناحية ارتفاع تراكيز الصوديوم Na% تبين ان 79.5 % من العينات غير صالحة للاستخدام الزراعي ، وبناء على معامل امتصاص الصوديوم SAR تبين ان 72.7 % هي ممتازة و 2.3% من العينات غير صالحة للاستخدام الزراعي، وصنفت من ناحية ارتفاع نسبة البايكاربونات بناء على معامل كميات المتبقية من الصوديوم والكربونات (RCS) تبين أن 90.9% من العينات جيدة للاستخدام الزراعي و 4.6 % غير صالحة للاستخدام الزراعي .

إن استمرار ارتفاع تراكيز الأملاح في المياه الجوفية في الآبار في أريحا واختلاف تراكيز العناصر الكيميائية المستمر يؤدي إلى تقليل إنتاج العديد من المزرعات التي لا تستطيع تحمل الارتفاع المستمر في التركيب الكيميائي للمياه، وبالتالي سوف يؤدي إلى تغيير الأنماط الزراعية في الأغوار، حيث إن المزارعين في الأغوار اتجهوا إلى زراعة أشجار النخيل حيث إنها تتحمل ارتفاع نسبة الأملاح مع العلم أن شجرة نخيل واحدة تحتاج إلى ما يقارب 100 متر مكعب في السنة وهذا بدوره سوف يؤدي إلى زيادة الضغط على الخزان الجوفي الضحل.

إن استخدام التقنيات الحديثة في معالجة المياه وبخاصة عملية التحلية سوف تعمل على حل المشكلة التي يواجهها القطاع الزراعي في الأغوار وبخاصة أريحا المتمثلة بالارتفاع المستمر في نسب الأملاح والعناصر الكيميائية.

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Table 1.1: General

Chapter one:

Introduction:

1.1 Introduction

Palestine suffering from high level of unstable environmental situation, where the amount of available water resources for domestic and irrigation are decreasing due to the limited amount of rainfall recently and the hard climate and degradation quality of groundwater, in addition to the political conflicts. All of these factors lead to lose the sustainability in water resources.

Limited available water resources affect surface water and groundwater in terms of quantity and quality. The fluctuations of rainfall in the region affect the rain fed crops and the discharge springs decline when the recharge rate for the ground water decreases.

Brackish water does not have any exact definitions where the brackish water can be defined as kind of water the salt content less than sea water content. (NGWA) 2010.

Total dissolved solid in brackish water are ranging between 1000-10000 part per million (ppm). Table 1.1 present the general categories of water based national ground water association (NGWA) 2010.

Table 1.1: General categories of water according (NGWA) 2010

Category of water	TDS(mg/l)
Fresh	0-1000
Brackish	1000-10000
Saline	10000-100000
Brine	>100000

Due to the limitation of water resources in west bank especially Jericho area brackish water can play as potential sources for agriculture purposes.

Water desalination has become an urgent need to solve the shortage in water resources in the region. Many water desalination technologies have been developed during last decades such as (Reverse Osmosis (RO) Electrodialysis reversal (EDR), Nanofiltration (NF), Membrane distillation (MD).

Water desalination technology has become one of the most important solutions to find new clean water resources. The desalination technology becomes one of the solutions to overcome increasing of ground water salinity in the lower Jordan valley.

1.2 Problem statement:

Jericho area with increasing water degradation in term water quality and quantity due to the limitation of water resources and low recharge for this resources due to the low rainfall precipitation and increasing on water demand lead to increase the salinity and changing the ground water chemistry in Jericho area.

Increase the salinity in the ground water lead the farmer to change their agricultural pattern where starting farming type of plant can holding high salinity like date trees where one date trees need approximately 100 cm /a and that increase the pressure on the shallow aquifer most important challenge that facing the development of agricultural sector.

High water salinity lead to increase the soil salinity especially the soil in Jericho area Considered as soil with high salt content.

1.3 Objectives

The objectives of this study are the following:-

1. Estimate the current amount of brackish water in Jericho area.
2. Assessing the effect of natural recharge on the salinity trend.
3. To evaluate the extend of salinity problem during last year's according historical data.

1.4 Research Questions

1. What is the amount of brackish water in Jericho area?
2. What is the spatial and temporal effect of recharge on the salinity trend?
- 3- What is the best location for possible remediation process?

Chapter Two:

Study Area:

2.1 Study area:

The study area located in the West Bank-Palestine. Jericho district is located in the eastern side of the West Bank. The district covers approximately 353,300 dunum, where 5910 dunum are controlled by Israeli Occupation and 5910 are used by Palestine population. Table 2.1 summarized the land use classification in Jericho districts. (Arij 1995).

Jericho City considered as the oldest city in the world (dating back to 7000 BC) and the lowest city on the earth it's approximately 250 meters below sea level (m.b.s.l).

The distance between Jericho and the Dead Sea is 10 km to, and around 7km to the west of the Jordan River. (Figure 2.1)

The population density in Jericho district is less than other areas in the West Bank, where the population intensity fluctuating widely due to wars and political conflict. The population in Jericho area are distributed mainly in the city of Jericho and four villages which are (Al-Uja, -Nawelma, Dyouk, AL- Jeftlik)and two refugee camps (Ein Sultan ,Aqbat Jaber). (Arij 1995).

Chapter Six

Conclusion and Recommendation

6.1 Conclusion

Ground water resources in Jericho area are very limited and it depend on the water discharging from spring group and water abstract from the Plio –Pleistocene aquifer.

Jericho area also suffering not only from the limitation in water resources but also suffering from the quality and the quantity of amount of water pumped from the Plio –Pleistocene aquifer. The calculated amounts of brackish water in Jericho area are approximately 8.6 MCM/a where calculated for forty four ground water wells during 2010-2011.

Four water types identified in ground water samples these are Mg-Na-Cl type which is the major one (86% of the sample), and Na-Cl, and Na-Mg-Cl type.

Classification of ground water sample based on salinity hazard identified that 100% of the samples are unsuitable for irrigation, and based on total hardness 93.2 % classified as very hard, and based on sodium hazard % Na 79.54 % of samples classified as unsuitable for irrigation and for SAR 72.7% of the sample are excellent and 2.3% are unsuitable for irrigation, classification based on bicarbonate hazard 90.9% of the sample are good and 4.55% of the sample are unsuitable for irrigation.

During the last 20 years the average water salinity increase from 1.5 to 4.5 mS/cm, and the borehole production decrease from 10 MCM/a decrease to 8.5 MCM/a within the last 10 years.

Possible remediation process for the aquifer through the artificial recharge ponds along the surface drainage system were the electrical conductivity and the chloride concentration start to decrease were the recent alluvium deposit of Wadi AL-Quilt consider as strong system for recharge the aquifer.

6.2 Recommendation

1. Control of over pumping in order to prevent abstraction rate excess the recharge rate.
2. Drilling new boreholes to discharge the brine water in order to prevent the mixing of fresh water with brine water.
3. Increase hydrological study in Jericho area should be carried out in order to predict the agricultural and hydrological situation in the future.
4. Increases awareness for the stakeholder environment for the new desalination technology.