Groundwater Artificial Recharge

The Marj Sanour Watershed - Palestinian Occupied Territories

THE REGIONAL KNOWLEDGE NETWORK ON WATER - RKNOW

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R-KNOW partnership

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GROUNDWATER ARTIFICIAL RECHARGE

SUMMARY

Groundwater forms the main water source in the Marj Sanour Watershed. While, domestic water is mainly abstracted from deeper aquifers, shallow aquifers are mainly used for agricultural purposes. Due to drought and the over pumping of agricultural boreholes drilled in the area, groundwater levels of shallow aquifers dropped to more than 80 meters during the last ten years and caused serious reductions in pumping from agricultural wells. This has obliged farmers to seek alternatives to increase water availability to sustain agriculture in the area.

Artificial recharge is one of the most promising alternatives that can contribute to enhancing ground water supplies. Groundwater recharge wells are suggested to be one of the most appropriate techniques that best suit the Marj Sanour area due to the following reasons:

1. Availability of floodwater on an annual basis in the area, which submerges large parts of the Marj for a few months.

2. Availability of good storage potential within shallower aquifers.

Accordingly, the Palestinian Hydrology Group (PHG) has proposed a pilot project to drill two artificial recharge wells within the Land and Water Resources Management Project funded by the Netherland Representation Office (NRO). The aim is to assist in recovering the accelerated decline of groundwater levels and minimize the submerged agricultural area.

These two wells were drilled in the area where mostly flooded, while recharged water passes through a filtration system that was built for this purpose. However, these two wells depending on their recharge capacity will recharge the shallower aquifer by about 9,000m^3/day.

Introduction

Groundwater Artificial Recharge is considered one of the main means of enhancing groundwater resources, regulating surface flow, providing underground storage of water and avoiding its loss in seas or in salt depressions. . With the accelerated overexploitation of the water table in aquifers, artificial recharge of groundwater can be an effective solution to preserve the water resources and restore the threatened water table aquifer.

Artificial recharge has several methods that can be adopted depending on the nature of each situation such as infiltration basins and canals, water traps, cutwaters, surface runoff drainage wells, septic-tank-effluent disposal wells, and the diversion of excess flows from irrigation canals into sinkholes.

In Palestine, groundwater forms the main water source, where several wells were drilled in the area targeting the different aquifers. Due to overexploitation, the groundwater level shows a considerable drawdown with time in some aquifers in the area. Surface water in the area is mostly not used due to the political situation, where rainwater mostly drains during rainy months towards the Mediterranean to the west or to the Jordan River and Dead Sea to the east. Thus, rainwater could form a potential source to recover the depleted aquifers in the area.

Marj Sanour Watershed

Marj Sanour is located in the northern part of West Bank within Jenin governorate area, Figure 1. Regarding its topographical and hydrological nature, Marj Sanour watershed forms a unique closed watershed in the West Bank. The catchment area of Marj Sanour covers about 59 Km^2, among this are, sixteen thousand donums form the Marj lake area that is considered one of the most fertile agricultural areas in the Palestinian territories, while other areas are hilly areas. The watershed has nearly a rectangular shape with northwest-southeast elongation; length of Marj Lake from northwest to southeast reaches 5-8 Km of 2-4 Km in width.

The lake region is located between the 350 and 375 contour lines. Rainfall precipitates in the area from October to May ranging between 400 to 1200 mm with an average of 634 mm.

Carbonate rocks mostly outcrop in the surrounded mountainous area, while these rocks overlain by a thick mantle of soil that in some places reach to more than 30 meters in the lake area. This dark brown soil is composed from clay, silt, sand, and gravel. This type of soil is characterized by its high ability to store water and low permeability. Rain-fed crops are mostly cultivated in the plain area of the lake, while

irrigated crops occupy limited areas. Rain-fed trees such as olives are mostly cultivated in the surrounding hilly area.

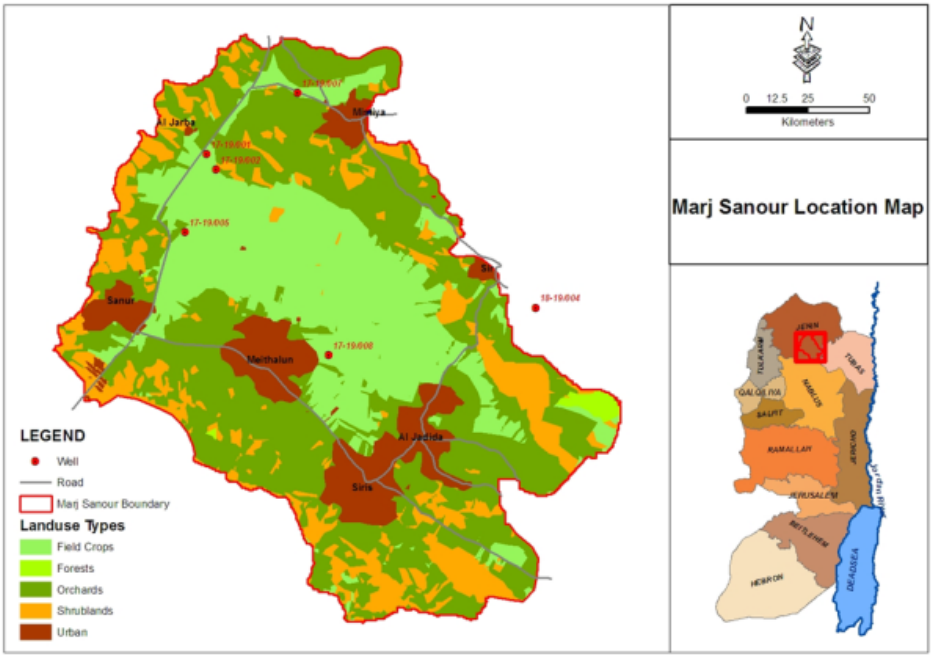
Hydro-geological Setting:

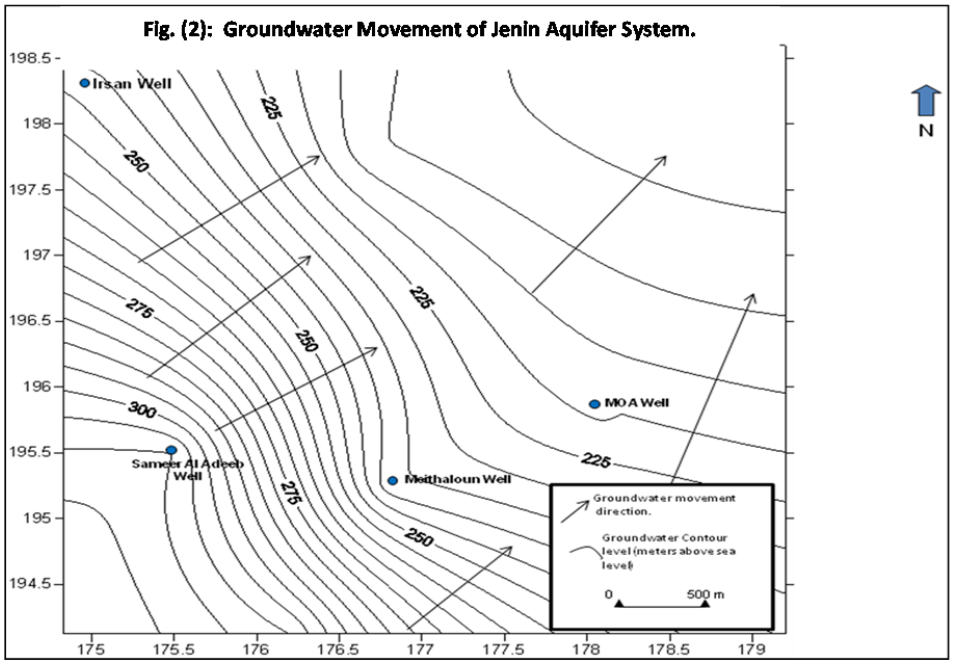
Hydro-geologically, Marj Sanour watershed area is located within the area of the northeast groundwater basin (Jenin-Nablus basin). The Area of this basin covers about 1050 Km2 with an Annual recharge of the Northeastern groundwater basin to be estimated at 145 MCM; 116 MCM coming from West Bank area, while 29 MCM coming from outside areas. Within the watershed area, the groundwater moves towards the northeast and east, Figure 2.

The main potential aquifers in the Marj Sanour watershed area are:

- The Jenin formation (Eocene Formation): Due to its lithological composition, the Jenin formation forms a local aquifer in the area. Through the drilling of several wells, it is found that the hydraulic properties of the Jenin aquifer are varied widely. This variation is suggested to be as a result of marl and chalk intercalations, and the great fluctuation of the water level due to the rainfall variations. However, the Jenin aquifer is mainly exploited by several wells distributed in the region. At present, the depth of the water level in this aquifer

Figure 1 : Marj Sanour watershed; location and land use





ranges between 130 and 150 meters below ground surface.

- Turonian-Upper Cenomanian aquifer system: The three formations, Jerusalem, Bethlehem, and Hebron, form one aquifer unit characterized by its high groundwater potential. This aquifer system is separated from the above Jenin aquifer by Senonian aquicludes. The Senonian aquicludes contributes to the aquifer's confined nature and gives it natural protection from surface pollutants. The Turonian-Upper Cenomanian aquifer system in Jenin Governorate area, particularly in the synclinal area, is at depths greater than 700 meters at certain locations. The Meithaloun deep well drilled recently (1302 m deep) has therefore targeted this aquifer system.

Based on the study conducted by the Palestinian Hydrology Group in 2008, the quality of water in the Marj Sanour watershed has been shown that the majority of water abstracted from groundwater wells are of a calcium – Bicarbonate quality. Results of the analyses show the Total Dissolved Solids (TDS) ranging between 370 and 1049 mg/l, medium hard to hard, Nitrate ranges from 15 to 80 mg/l, and Chloride ranging between 57 and 264 mg/l. The sodium hazard (SAR) of the analyzed samples is within low range. While the study showed that all collected samples are biologically contaminated and need to be treated if used for drinking, floodwater analyses results shows that on average the TDS concentrations are 230-260 mg/l, Nitrate is lesser than 20 mg/l, Sodium is ranging between 28 and 34 mg/l, and Potassium ranges from 3 to 5 mg/l, clarifying that the flood water is of good quality which is close to rainwater properties.

Problem Statement

The problem in the Marj Sanour watershed area is a double face token; water scarcity and flooding. These two problems originate from the same root: mismanagement of the land and water. Due to the drought years witnessed in the region and to the increased groundwater over-pumping from wells drilled in the shallow aquifer (mostly used for agricultural purposes) during the past few years, groundwater levels show a drop of about 70 m during the period between 1969 and 2013 (Fig. 3). As a result of the water level decline, pumping capacities of the wells was reduced while the water quality deteriorates. This in turn is negatively affecting the agricultural sector.

Furthermore, as a result of its nature (a closed basin without any natural outlet to drain water, and thick clay soil covers the Marj area with low permeability), Marj Sanour forms a closed watershed; in heavy rainfall years Marj Sanour lake is flooded by rainwater that drains from surrounding wadis, and from rainwater directly precipitates on the lake area itself. Several direct and indirect harmful impacts of the flooding were encountered; limiting cultivation land, reducing the cops' productivity, leaching downwards soil minerals and fertilizers, growing of harmful and undesired grass, increasing anaerobic reactions and limiting aerobic bacteria activity.

Groundwater Artificial Recharge

The idea of groundwater artificial recharge has been studied and discussed further with stakeholders through a regional EU funded project "The Social, Ecological, Agricultural Resilience in the face of climate change (SEARCH) project (2011-2014)" that was carried out in Marj Sanour area. The project developed a resilience framework for adaptation to climate change that includes among other measures; the implementation of artificial recharge interventions.

Therefore, PHG in cooperation with watershed stakeholders proposed a plan of drilling ten artificial recharge wells in the Marj area to recover the water level of the shallow Eocene aquifer. However, it was agreed to implement a pilot project in demonstration sites to enable joint learning with stakeholders, through local action planning and testing interventions designed to increase climate change resilience. The pilot project was presented for funding within the framework of the NRO funded Land and Water Resources Management Project in 2013.

Following the approval of funding, a workshop was conducted in the united municipality of Marj Sanour

and in the presence of the Water Authority, Ministry of Agriculture, Palestinian Hydrology Group (PHG), Union of Agricultural Work Committee (UAWC), farmers, Marj Sanour Watershed Association, and well owners to discuss the proposed location of the pilot artificial recharge wells. As stakeholders agreed, the Watershed Association will supply the required land, while the association with the support of all stakeholders will follow and manage the project. The location of the boreholes were chosen in the area of the Marj that is mostly exposed to flooding and that is away from the mainstreams to avoid strong runoff loaded with huge quantity of suspended materials.

The aim of these wells is to recover the severely declined water level of the shallower Eocene aquifer in the watershed and the surrounding areas, and to minimize the submerged agricultural area.
PHG was then asked to design the wells and develop the technical specifications in a way that meet the aim of the project and ensure that the aquifer is enhanced while its water quality does not deteriorate. PHG therefore, determined the depth of the wells and designed an outer filtration system surrounding the wells in order to reduce the turbidity and the amount of the suspended solids of the recharged water (Fig. 5). The filtration system comprises of the following:

- Two squares of stone gabion where built around the borehole, the outsider gabion consists of stones with diameters ranging between 15-20 centimeters, while, the inner one was built by using 7-15 cm stones diameter (Fig.4).
- The 16" casing pipe that was installed into the well to support well walls was perforated in front of porous rocks and one meter above the ground surface to act as another filter system of the water before entering the well.
- The depth of each well (124, and 127 m) is less than the needed depth to reach the groundwater level in the area, which is at around 140 meters depth. This also will play a good role in the water filtration, where water will pass through unsaturated rocks of at least 20 meters, which will act as an additional filter to the recharged water before it mixes with the aquifer's groundwater.

After the completion of the wells, a recharge test capacity was conducted. Test results of the two boreholes have shown that, the estimated recharge capacity of the southern well was about 8033 m^3/day, while the capacity in the northern well, may reaches about 1104 m^3/day.
It is planned that the groundwater level will be monitored through the surrounding agricultural wells in the area.

Figure 4: Filtration System - Gabions

Conclusion

Artificial groundwater recharge is considered as a possible technique that be adopted in depleting water table areas in Palestine. Artificial recharge can be used to recover the water level in overexploited water bearing formations, dilute the salinity of groundwater, and reducing the negative impacts of flooding, as it is the case in Marj Sanour area. The data and information that will be generated through this, may help in scaling up and planning of other artificial ground water recharge projects in the area that in turn enhance the groundwater resources.

References

- Arab Organization For Agricultural Development,(2008), The Technical study for Marj Sanour Development Project.
- FAO, (2000), Irrigation and Drainage Paper No. 56, Crop Evapotranspiration (guidelines for computing crop water requirements).
- Palestinian Hydrology Group, (2009). Watershed Management Model at Marj Sanour, Water Resources Assessment, Palestinian Hydrology Group (PHG), Palestine.
- Palestinian Hydrology Group, (2010), Environmental Impact Assessment Report for Marj Sanour Watershed, Palestine.
- Palestinian Hydrology Group, IUCN, UAWC, (2013), Vulnerability Assessment Report: Marj Sanour Watershed.
- Wishahi, S. (2007). Watershed of Marj Sanour, PHG, Palestine.o
- Wishahi, S. and et.al. (2004). Water Resources Assessment in Meithaloun town, Empowers Project, Palestine.
- Wishahi, S., and others (2004). Water Resources Assessment in Meithaloun town, Empowers Project, Palestine.