Management of Coastal Aquifers – The Case of a Peninsula – State of Qatar

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ABSTRACT

The State of Qatar is a desert country characterized by its arid to hyper-arid climate. The setting is that of a peninsula, measuring an average of approximate ly 80 km across and 185 km long, covering an area of around 11493 km2. Much of the population resides in the urban, coastal setting of Doha city, with a number of farming areas scattered across the country, especially in the northern half. The tremendous fast paced development throughout the country is leading to increased population, improved standards of living and industrial growth. Obviously, this is putting immense pressure and demand on water sustainability.

The average annual rainfall for the period from 1972 to 2005 (figure 1) is 80.2 mm (Agro-hydro-meteorological Yearbook 2006). This has been the main source of recharge to the groundwater aquifers which are used mainly for agricultural applications. However, the rate of abstraction is becoming far greater than the rate of natural recharge, resulting in lowered aquifer water levels and sea water intrusion that has led to increases in groundwater salinity. Historical data has been collected and a number of steps put in place to address the issues of water quality and quantity in this coastal settings.

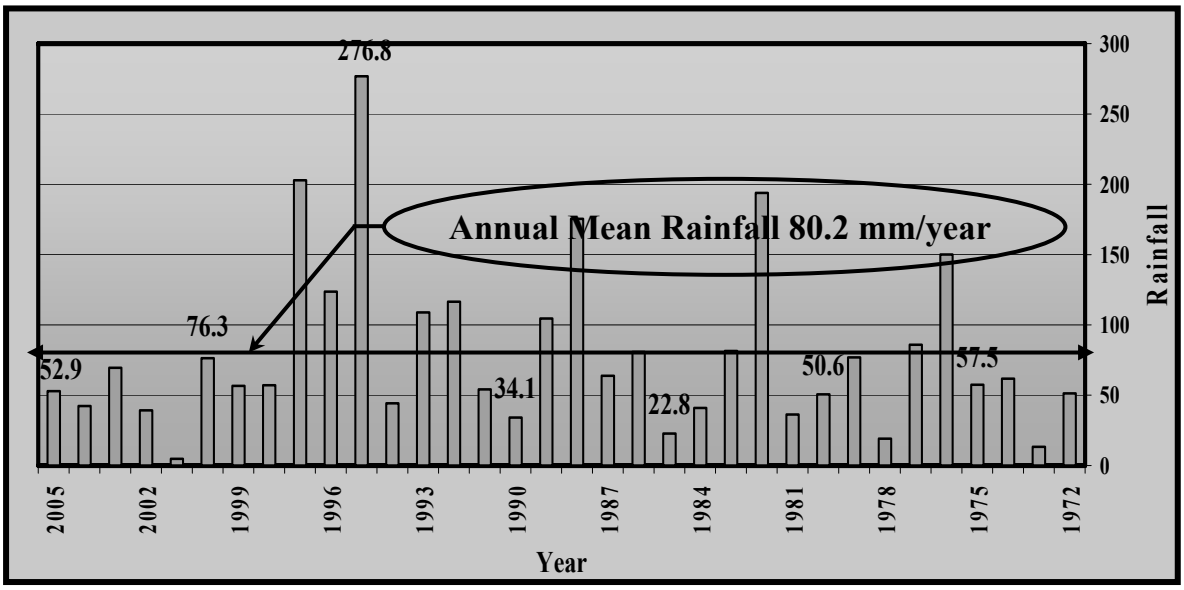

Figure 1. Annual Total Rainfall for the State of Qatar (1972 – 2005)

Steps taken in assessing and addressing saltwater intrusion have included groundwater monitoring, data management, aquifer characterization and modeling, artificial and enhanced recharge and other relevant remediation techniques. The plans and taken actions being carried out are expected to lead to a net positive groundwater balance.

INTRODUCTION

In the light of a sparse, often unreliable, winter rainfall, sustainable agricultural development remains the main goal of a groundwater resources management plan in the State of Qatar. Agriculture is the main user of the groundwater, and its unplanned extraction can lead to deterioration of its quality and quantity in this coastal environment.

Potable water supplies are met through a rapidly growing production of desalinated water, without putting any stress on the groundwater. In addition to that, an ambitious expansion and upgrading of existing wastewater treatment facilities is underway, providing a potential source of high quality, treated wastewater for irrigating fodder crops and landscape needs. In the urban setting of Doha city, the shallow water table is known to recharge through rainfall, (landscape) excess irrigation and leaking utilities. A rising water table, compounded with saltwater intrusion and storm water management in this area of high rise commercial and residential buildings, is making it necessary to provide an effective control system.

BACKGROUND

In the last couple of decades, groundwater in the State of Qatar has shown severe decline in actual water levels, seawater intrusion, upcoming and a rapid increase in water salinity. The depletion in groundwater resources is revealing itself in the abandonment of farms especially in coastal areas and in rapid soil degradation (Amer and Al-Mahmoud, 2003).

Qatar had realized early the need to put in place a program to address saltwater intrusion and support groundwater recharge through artificial and enhanced techniques. Some 341 recharge stations were identified, designed and established within over 850 identified depressions. These stations capture the flood events and other than having the primary objective of groundwater recharge, also helped mitigate runoff damage to surrounding agricultural land. Monitoring stations have assisted in evaluating the benefits of this significantly enhanced recharge scheme. This early success has led to plans through further enhancements to boost the annual recharge by a staggering 50%.

Although studies have shown the existence of relatively good quality groundwater in the central areas, saltwater intrusion has progressed indiscriminately over the years in the coastal areas (fig. 2). This progression is now threatening the long term sustainability of the groundwater aquifers in the country.

METHODS

As a result of the rapid expansion of farming areas in the northern part of Qatar, the fresh and slightly brackish groundwater resources are being over-exploited at an accelerating rate. This is leading to a fast rate of depletion of the aquifers, accompanied by a deterioration of water quality. The evaluation of the natural and artificial groundwater recharge in the country is becoming an essential requirement of any future groundwater development. A number of investigations and studies are in various stages of planning and implementation to improve the long term groundwater sustainability and address the issues of saltwater intrusion in the country. Departmental coordination is being practiced to facilitate the interaction of all stakeholders towards a common goal.

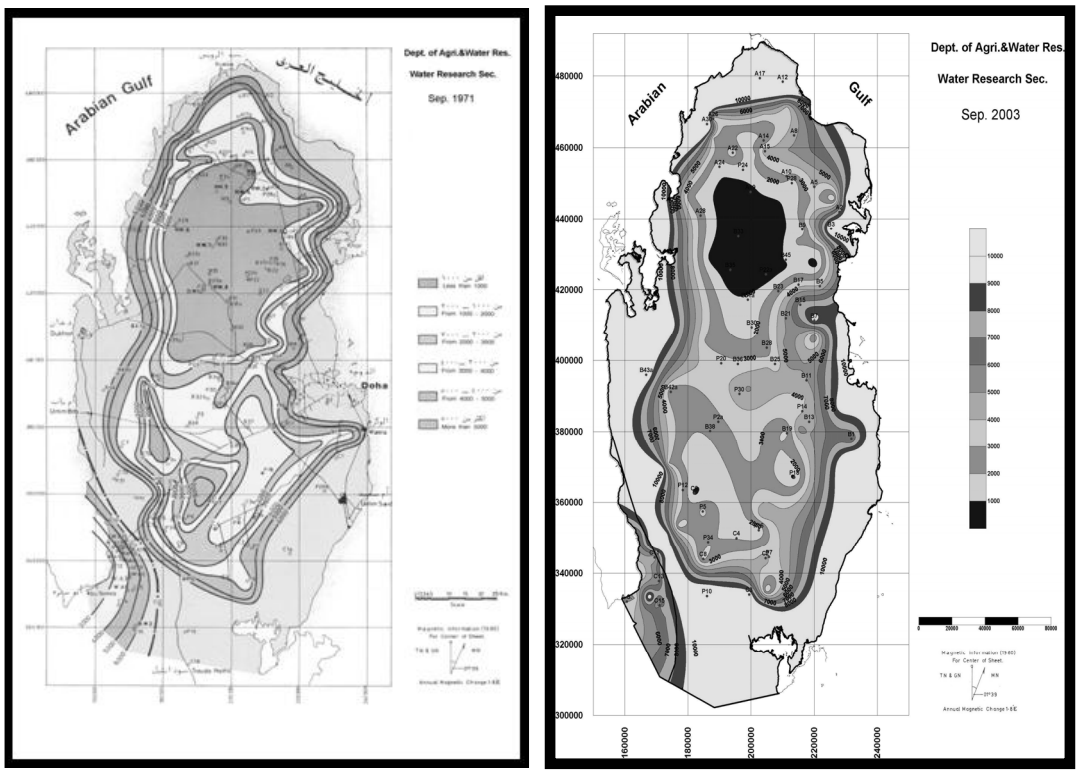

Figure 2. Comparison of the freshwater lens (TDS < 1000 ppm) for the years 1971 & 2003

The backbone of the field studies of groundwater program in the country is the wells survey and abstraction and recharge study. It calls for the determination of absolute water levels, water quality measurements, abstraction rates, recharge wells efficiency, water use, topography related surface flows, etc. It will lead to the creation of a master data repository that will be hosted on an online Geographic Information System (GIS) database. An example of such a system is illustrated in fig. 3. Data that is compiled as part of the projects and all related analysis, interpretation and visualization results will be made available for real time access through this application. This will greatly facilitate the analysis, implementation and evaluation of different techniques for saltwater intrusion control programs. The updating of the current groundwater monitoring system and its expansion will provide valuable insight into the state of the aquifers.

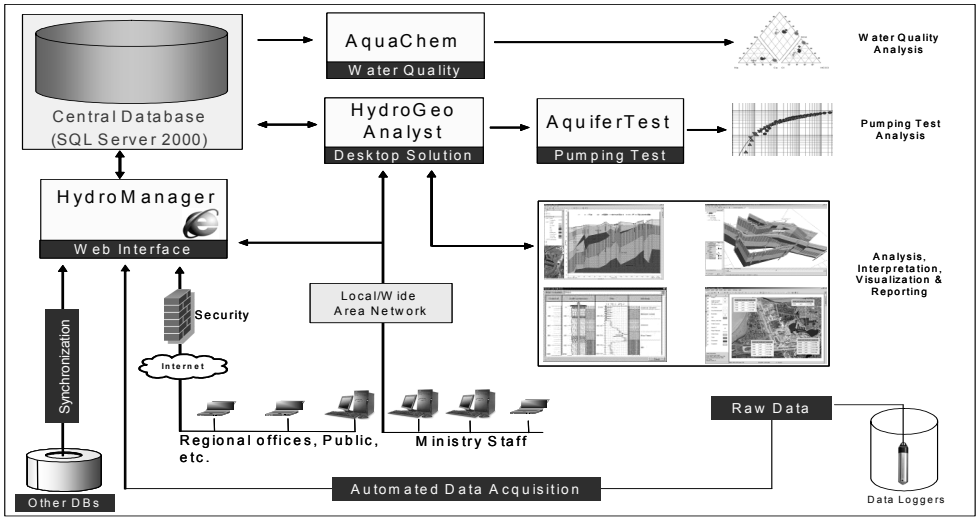

Figure 3. An Example of an Online GIS Data Management System

Capitalizing on the growing availability of alternate water sources such as desalinated water, artificial recharge has received much attention with a view to improve groundwater sustainability.

For the urban setting of Doha city, the evaluation of the groundwater conditions in the areas of interest and a selection of suitable groundwater monitoring sites to understand and address saltwater intrusion is required. On a few sites, the grouping together of shallow and deeper sites as monitoring nests will help improve the understanding of the vertical flows from the upper aquifer to any underlying aquifers and vice versa. Areas of potential groundwater issues within Doha city will be influenced if groundwater is moving through fractures to deeper units. Based on the preliminary work and the carrying out of land surveys, initial monitoring sites can be selected. Investigative drilling, geophysical logging and hydraulic pump testing can then be carried out at these sites. The advanced geophysical logging improves our understanding of the geology across the drilled wells. It provides vertical profile for the aquifer specific yield, hydraulic conductivity, water salinity, and the existence or absence of fractured layers.

DISCUSSION AND CONCLUSIONS

The country's saltwater intrusion control program lays the emphasis on predicting the impact of saltwater intrusion as a result of the severe over pumping of groundwater in the coastal regions of the country. In the urban coastal areas, it calls for the design and optimization of the pumping well locations for dewatering projects aimed at mitigating the impact of saltwater intrusion on the foundations of high rise buildings. Recommendations and actions will include the evaluation of the pertinent and effective groundwater remediation systems in this arid setting and an assessment of remaining risks. Learning from the past practices and recent and ongoing work, harnessing the full potential of available water sources through the means of artificial and enhanced recharge is starting to present a very promising future for groundwater sustainability and saltwater intrusion control in the State of Qatar. Through the past, ongoing and future studies, techniques and methods in hydrogeology and data management are expected to be combined in order to establish a comprehensive groundwater information system as a powerful planning tool for remediation techniques in order to ensure sustainable groundwater use.

REFERENCES

Amer, K. M. and Al-Mahmoud, A. M. (2003), "Water Resources Management and Development to Combat Water Scarcity in Qatar", Proceedings of Water Middle East, International Exhibition and Conference for Water Technology, Manama, Kingdom of Bahrain, 6-8 October, pp. 13-26

Agro-hydro-meteorological Yearbook 2006. Agro-hydro-meteorological sub-section, the Department of Agriculture and Water Research, Doha, State of Qatar.

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