Prospective Regulatory Environmental Services Provider for Aquifer Recovery

N. H. Elnwishy

Biotechnology Research Center, Suez Canal University, Ismaillia, 41522, Egypt. *Email*: nwishy@yahoo.com

ABSTRACT

Aquifers are source of potable water in many sites in Egypt. For years, farmers have dug many wells to drink, supply the rainfall and to grow crops. But then, overexploitation of this groundwater became a major concern especially with climate change problems. In most of Egyptian sites, the aquifer system doesn't have the capacity to support full irrigation. Thus, traditional and modern techniques were both employed to artificially recharge the groundwater. Also, optimization of water use efficiency became necessary to face the droughts and the declining freshwater resources; especially when only 20 to 75 % of water extracted from underground aquifers is recovered through natural recharge, which is a leading factor to a continuous decline in available groundwater.

Meanwhile, mangrove *A. marina* ecosystems, growing in the intertidal belt at the interface between land and sea, play vital roles in preserving the environmental ecosystems. Because besides supporting wind breaking, sediment retention and erosion control, supplying aquifers is one of these roles. Mangroves also contribute to water quality maintenance. In addition to these direct support provided by mangroves to the economic activity and property, the indirect used for domestic, agricultural and industrial purposes.

Key words: Environmental services, mangrove, aquifers, economic values.

1. INTRODUCTION:

There are 238 million ha of dryland forests in the world and Africa alone has 64% of these forests. A total of 124 countries and areas were identified as containing one or more mangrove species. Mangroves are intertidal plants that occur in the interface between land and sea. Mangroves possess a range of features which make them uniquely adaptable to their stressful environment (e.g., they are holophytic or salt tolerant, have aerial roots for gathering oxygen, and seeds that germinate on the tree). The ecological role of mangrove ecosystems is, economically and socially, highly significant. They are well known for their high biological productivity and their consequent importance to the nutrient budget of adjacent coastal waters. They are the most typical forest found on the coastlines in the tropics and subtropics (Singh and Odaki, 2004) and the areas where they exist are rich in biological diversity of flora and fauna (EEAA, 2005). In Egypt particularly, the most abundant species are *Avicennia marina* and *Rhizophora mucronata* (FAO, 2007).

This paper briefly explains the importance of mangroves such as *A. marina* to aquifers recharging and its vicinity, and the opportunities that may result from its rehabilitant.

2. OBJECTIVE:

This review aimed to explain the biological and economical importance of mangroves A. marina to aquifers recharging and its vicinity, and the opportunities that may mitigate most of the environmental concerns raised by farmer community, policy makers, and governments.

3. ENVIRONMENTAL IMPORTANCE OF MANGROVES:

3.1. Importance to Water resources and aquifers:

Mangrove ecosystem serves as ground water pump and barrier between the aquifers and the sea. Ground water recharge involves water movement from the mangrove to an aquifer can (1) remain as part of the shallow groundwater system, which may supply water to surrounding areas and sustain the water table recharged (Al-Mufti, 2000) or (2) may eventually move into the deep groundwater system, providing a long term water resource. While, the function of discharge of groundwater into surface water like springs involves the role of mangroves in releasing water from aquifer sources which may be important to prevent flooding when upland water tables are high, just like a control valve. Also, mangrove may contribute to water quality maintenance functions by nutrient transformation, retention of toxins and particle suspension which may be caused by salt water intrusion to aquifers and leaching of heavy metals present in fertilizers (Camille B., 1997).

The flood and flow control services of mangroves is usually important. The valuation methodology is similar to that for groundwater discharge. Thus, it is necessary to know the extent and frequency of flooding in the flood plain area that would occur if this mangrove function did not exist (Camille B., 1997). The retaining of flood and the control of flow may also lead to a higher chance to ground water recharging by this flood.

3.2. Importance to Water de*salination:*

Mangroves normally have aerial dark brown roots which grow apparently on the land level forming an intrinsic network which work as desalinator of the sea water so that enough moisture is available for growth (EEAA, 2000). In Egypt, mangroves are found forming part of the coastal marsh and high terrestrial dune vegetation (Sabkha), and totally lost their aerial roots. Mostly, they have adapted to this harsh environment by becoming completely terrestrial by a natural alteration (Khalaf Allah, 2002). This resulted in a high density of terrestrial vegetation consisted of terrestrial mangroves (Elnwishy *et al*. 2008). However, this natural alternation may bring up a new definition of mangroves varies from the common one, and it may push condense genetic investigation (Elnwishy, 2009)

3.3 Biological importance

Mangroves provide habitat, nutrients, and protection; thus preserve biological biodiversity of marine and terrestrial ecosystems. This may provide both food and shelter to organisms which is important for the life cycle of important plants and animal species. For some species, mangrove may provide elements required to complete their life cycle. Other species may depend on the mangrove for more complex life cycle, including several aquatic animals such which depend on mangrove areas for spawning and juvenile development (EEAA, 2005); also migratory birds depend on mangroves for part of their life cycle for resting or feeding while on migration (Baha El Din, 1999).

3.3. Importance to Soil and landscape:

Mangroves have the ability to accumulate sand dunes around the net of roots of mangroves. These dunes can reach up to 1- 1.5 m high (Elnwishy *et al,* 2008). Apparently, these dunes are caused by the deep roots (pneumatophores) of mangroves which trap terrestrial sand blown by wind, and/or caused by seasonal rain floods waters from highland wadis which may bring down sediments to lowland and coastal areas, causing much of the sediment to run-off into the sea. In either cases, the two functions may result in accumulation of land in the coastal plain, leading to extending the land slowly out to sea. According to Hefny (1997) this function result in reducing the risk of losing the surface nutrients sediment of the soil by water erosion into the sea, the loss can reach up to $>100 \times 10^3$ m^3 of sediments into the sea at a high risk level, and 50×10^3 in a low risk level.

4. SOCIO-ECONOMICAL IMPORTANCE OF MANGROVES:

4.1. *Recharging aquifers*

Groundwater recharge made by mangroves is a possible aquifer refill supplier which supports domestic agricultural and industrial purposes in the surrounding regions (EEAA, 2005) which is an additional value of mangrove. Moreover, the nutrient and energy flows of mangroves is believed to be able to stabilize local climatic conditions, particularly humidity and temperatures which has a valuable influence on any agricultural or resource-based activities, besides its ability to maintain water quality and retaining water toxins (EEAA, 2005) by its large net of wooden roots.

4.2. *Avoided floods' damage costs:*

Frequent flash floods were reported to cause significant damage (Hefney, 1997). The avoided damage costs with the presence of mangroves, or the flood prevention expenditures or the replacement cost technique were reported significant (EEAA, 2006). These sediments in most cases may contain high contents of organic nutrients, including those from animal waste which add the value of nutrient retention to mangrove.

Protection provided to economic activity and property by the mangroves regulatory environmental services are significant (EEAA, 2005). The damage mangroves are exposed to by strong wind is significantly limited (Galal 1999), therefore it functions as a strong and effectively tolerant wind breaker. The total of avoided damaged caused by storms provided by mangroves is valuable cost. In addition, the avoided costs of building alternative wind breaks or sea walls other than mangroves are also high. For instance, as reported by WRM in 2005, studies of the 2004 Asian tsunami showed that areas near healthy mangroves suffered less damage and fewer loss of life. In Myanmar, mangrove forests could have reduced damages resulting from the waves caused by cyclone Nargis (FAO, 2008).

4.3. *Raising new activities:*

Mangroves are significant plant for sea water agriculture approach to mitigate the severe lack of fresh water (Elnwishy *et al*., 2009). Seawater agriculture is to grow salt-tolerant crops and plants such as mangroves on land using water pumped from the sea for irrigation (Boyko, 1967). It is based on breeding a common salt tolerance high yield crop, or select wild plants that already have high salt tolerance. It is also known as Saline Agriculture, salt farming, Irrigation with sea water or ocean farming. Mangroves are the best potential plant for this approach due to its ability to use saline water up to 45.000 ppm.

Fishing is an activity raised in drylands near shorelines (El Bastawisi, 1995), introducing bees to mangrove areas for apiculture was possible using *Apis mellifera* (FAO, 1994). Also the landscape afforded by mangroves to tourists in national parks and reserves is valuable to Bedouins who are increasingly getting involved in tourism (EEAA, 2005).

CONCLUSION:

A. marina can serve as a potential alternative and /or additional species of vegetation in coastal drylands where fresh water is scarce to support recharging aquifers, & to benefit from its environmental & economical services to promote the sustainable development process to local communities.

REFERENCES:

Al-Mufti, M. (2000) cited in Flora of Nabq protected area. *Published by Egyptian Environmental* Affairs Agency, Cairo, Egypt.

Boyko, H. 1967. Salt-water agriculture. *Scientific American.* 216:89-96.

Camille B. (1997) the Economic Valuation of Mangroves: A Manual for Researchers. International Development Research Centre, Ottawa, Canada

EEAA/ ITTO / MALR / MSEA (2006) Socio-*economic Assessment and Economic Valuation of Egypt's Mangroves.*

EEAA (2005): *EEAA/ ITTO / MALR / MSEA Project's Progress Report Number 4*, (March 2005 – August 2005)

El Bastawisi, I Y, (1995) *Anthropological survey of Ras Mohammed National Park Sector (South Sinai),* Development Project (5EM/03/220//025/A) for the National Parks of Egypt

Elnwishy N., Abichou H., Labiadh M., Abichou M. & Sabri D. (2009) Will mangroves become the future of seawater agriculture?, Conference of Land Degradation in Dry Environments, Kuwait.

Elnwishy, N., Abichou H., Labiadh M. & Zalat S. (2008) A promising vegetation type to sustain development in drylands. Journal of arid land studies 19 (1) 113- 116.

FAO (2008). *Intact mangroves could have reduced Nargis damage*. http://www.fao.org/newsroom/en/news/2008/1000839/index.html

FAO (1994): *Tree and Land Tenure Rapid Appraisal Tools*. Forests, Trees and People Programme Manual 4. FAO, Rome.

Galal N. (1999): *Studies on the coastal ecology and management of the Nabq protected area, South Sinai, Egypt*. Ph.D. Thesis, York University.

Hefny, K.(1997) *Study of wadi hydrology & flash flood hazards*. Egyptian Red Sea Coastal & Marine Resource Management Project

Khalaf Allah, A. (2002) *Ecological adaptation of Avicennia marina plants in Al-Qusseir region, Red Sea Coast, Egypt*. Ph. D. Thesis, Botany Department, Faculty of Girls, Ain Shams University.

Singh V., Odaki P. (2004): *Mangrove Ecosystem: Structure and Function*. Scientific Publishers (India), Jodhpur, pp. 297.

WRM (2005). Asia: The Ecological, Social and Political Dimension of December 26th Tsunamis. World Rainforest Movement WRM's Bulletin Nº 90, January.