Desalination and Water Treatment
www.deswater.com
3 (2009) 271–275
1944-3994/1944-3986

Climate change and water desalination in MENA — World Bank involvement

Khairy Al-Jamal

MNSSD, The World Bank, Palestinian Authority
Tel. +972 8 283 3301; Fax: +972 8 282 4296; email: kaljamal@worldbank.org

Received 10 September 2008; Accepted 7 January 2009

ABSTRACT

This paper presents the water sector challenges and the expected impact due to climate change in the Middle East and North Africa (MENA) region. The World Bank and other international funding agencies recognized the already existing water crisis in many places around the world. As an outcome to an integrated water resources management there will be a need for proper supply and demand management. However, the enhancement of the existing water resources via wastewater reuse and brackish and seawater desalination is eminent. It will be even applied at a larger scale when the adverse effect of the climate change on water resources will be considered. The World Bank is allocating billions of dollars to mitigate for the climate change and reduce the global warming effects via the improvement in the energy efficiency, energy conservation and enhancement of renewable energy resources. Some mechanisms where established that the water resources enhancement can benefit from. These include the Clean Development Mechanism and the Joint Implementation in relation to the Carbon Financing. The paper will touch base on the wide perspective of the Bank's initiatives and mechanisms aiming at securing water supply under expected increasing scarcity.

Keywords: Desalination; Climate change; Kyoto Protocol; Efficiency; Carbon finance; Reverse osmosis; Water scarcity; Demand; Supply

1. Introduction

The Middle East and North Africa (MENA) region is composed of 21 countries and territories: Iran, Iraq, Kuwait, Qatar, Bahrain, United Arab Emirates (UAE), Oman, Saudi Arabia, Yemen, Djibouti, Syrian Arab Republic, Lebanon, West Bank and Gaza, Israel, Malta, Jordan, Egypt, Libya, Tunisia and Morocco. In the year 2007, the total population reached 300 million inhabitants (Fig. 1) with a high rate of annual increase of 1.7% [1].

The region is characterized as semiarid. The annual per capita renewable water resource is limited to 1,100 m^3 (Fig. 2.) This puts MENA among the relatively water poor countries. The MENA region falls far below the global world average of 8000 m^3/capita per year and is expected

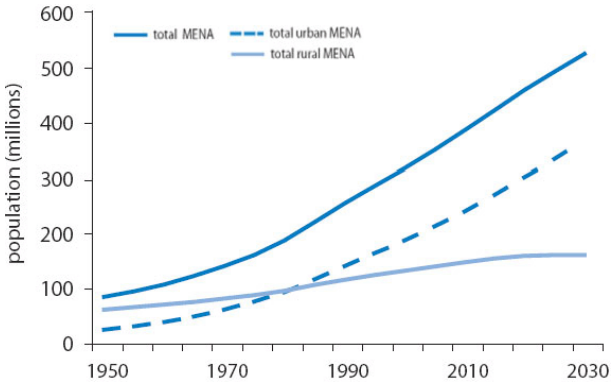

Fig. 1. MENA region rural and urban population trends, 1950–2030 (millions).

Presented at EuroMed 2008, Desalination for Clean Water and Energy Cooperation among Mediterranean Countries of Europe and the MENA Region, 9–13 November 2008, King Hussein Bin Talal Convention Center, Dead Sea, Jordan.

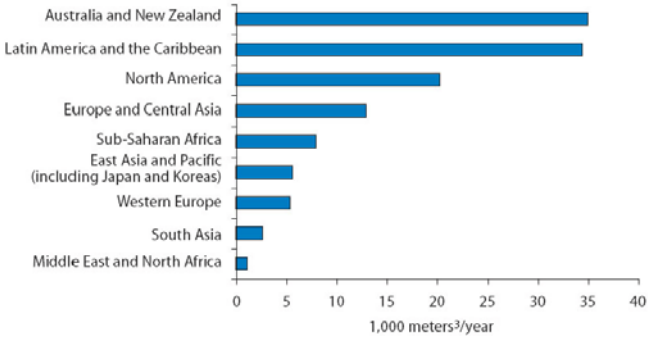

Fig. 2. Actual renewable water resources per capita by region [2].

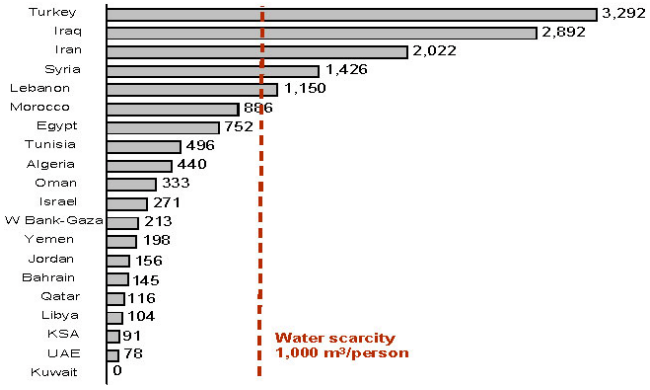

Fig. 3. Total renewable water resources per capita by country [5].

to fall to less than 550 m^3/capita per year, by the year 2025 [3]. It is worth noting that 60% of the water originates outside the region and the region is already exploiting more that 75% of its total available resources [2,4]. This makes it even more difficult in terms of achieving water security. It is also worth mentioning that these limited resources are not equally distributed and that they can vary from 0.0 to 3000 m^3/ capita per year in Kuwait and Iraq respectively (Fig. 3.)

The region is witnessing economic growth. The GNI is around US$ 2,481 per capita and the GDP rose by 24% between 1996 and 2006 [1]. Many donors are committed to the region's development. The World Bank has committed more than US$ 900 million for fiscal year 2007 and disbursement reached the level of $1,600 million for the same year with 20% for water sanitation and flood protection.

2. Projections of water demands

While the region is severely stressed in terms of meeting today's water demands, the situation is expected to worsen in the future. Demand is going to increase

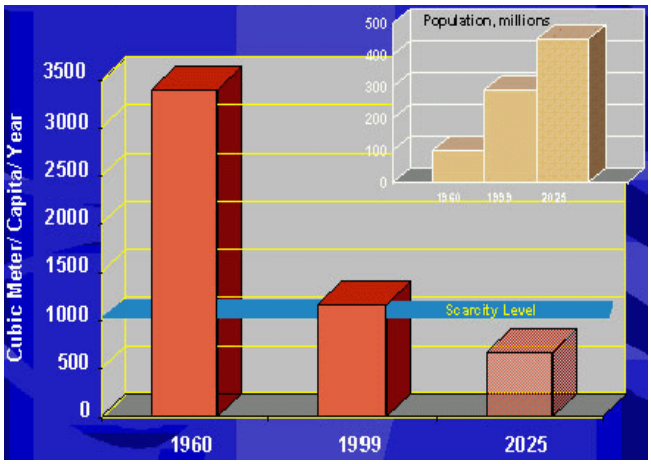

Fig. 4. Projected per capita water availability in MENA [6].

dramatically as a result of population growth, urbanization, economic growth and climate change. The latter is expected to be associated with rise in the region's average temperature that will in turn lead to increase in both domestic and agriculture demands; and reduction in the rate of precipitation. Assuming that the per capita annual supply will be maintained at 1000 m^3, then the total demand by the year 2025 will be 450×10^9 m^3/y (population will be around 450 million). Fig. 4 illustrates the expected population growth and the available renewable resources per capita per year [6]. The climate change effect on the region will be covered in the next section.

3. Climate change and water resources

In terms of water resources, MENA is expected to be negatively hit due to climate change. By the year 2050, the surface temperature is expected to increase by 2.5°C, the precipitation will decrease by 10.5% and the run-offs will decrease by 20% to 30% [4]. Thus the available renewable resources will decrease by around 20%, from 400×10^9 m^3/y to around 320×10^9 m^3/y. However, until the year 2025 there will be slight effect of the climate change, and for planning purposes the renewable resources capacity will be considered to be 370×10^9 m^3/y.

4. Bridging the gap and role of desalination

Under such expected unbalance between demands and available resources, the gap can be bridged within an integrated water resources management framework. On the demand side this will include water conservation, use efficiency, policies and measures to encourage saving such as metering and adaptation of a progressive tariff structure and on-site recycling. On the supply side, this will

include leak and loss minimization and enhancing new resources via wastewater reuse and seawater desalination. Water balance should be conducted on a country basis as the region has not developed the trade concept in water. The analysis on regional basis can be misleading. For instance, application of wastewater reuse (50% of domestic demand), reducing leak from 40% to 20% and increasing irrigation efficiency by 10% will save around 104×10^9 m^3/y. This is more than the gap of 80×10^9 m^3/y between demand and supply in the year 2025. However, even today, many countries from the region fulfill their water demand partially or totally through desalinated seawater. The region has around 60% of the world's desalination capacity (7.2×10^9 m^3/y). According to the countries plans and the historic desalination capacity increase, the total capacity is expected to reach 19.1×10^9 m^3/y by the year 2016 and possibly 31.4×10^9 m^3/y by 2025 [7]. This will count for around 39% of the anticipated region's deficit. Preferably the remaining deficit will be bridged through efficient demand and supply management. Table 1 summarizes the expected increase in the desalination capacities in potential countries of the region.

Table 1
Potential desalination capacity in MENA (1000 m^3/d) [7,8]

Country	Desalination capacity end 2006	Capacity forecast 2011	Capacity forecast 2016	Capacity forecast 2025[b]
Algeria	727	3191	4985	8,214
Egypt	432	528	888	1,536
Libya	899	1,869	3,775	7,206
Israel	440	1000[a]	1,790	3,212
Morocco	59	285	491	862
Tunisia	89	195	297	481
Jordan	240	541	898	1,541
S. Arabia	7,410	12,564	17,654	26,816
Kuwait	2,081	3,446	4,617	6,725
Bahrain	519	1,183	1,977	3,406
Qatar	1,197	1,676	2,481	3,930
Oman	377	1,140	2,059	3,713
UAE	5,730	9,030	12,330	18,270
Total (10^3 m^3/d)	20,200	36,648	54,242	85,911
Total (10^3 m^3/y)	7,373,000	13,376,520	19,798,330	31,357,588

[a]Estimated. [b]Extrapolated.

5. World Bank portfolio to foster and manage climate change

The World Bank Group is playing a responsive role to mitigate the impacts of the climate change. This includes the increase of its funding for energy efficiency, energy saving, promotion of renewable energy, wastewater reuse and the promotion of desalination. The energy efficiency and saving portfolio reached US$1,443 million for the year 2007 out of which US$121 million was for MENA. The annual commitment increased sharply since 1990 when there was hardly any commitment made at that time for energy efficiency and renewable energies by the World Bank group at that time (Fig. 5.)

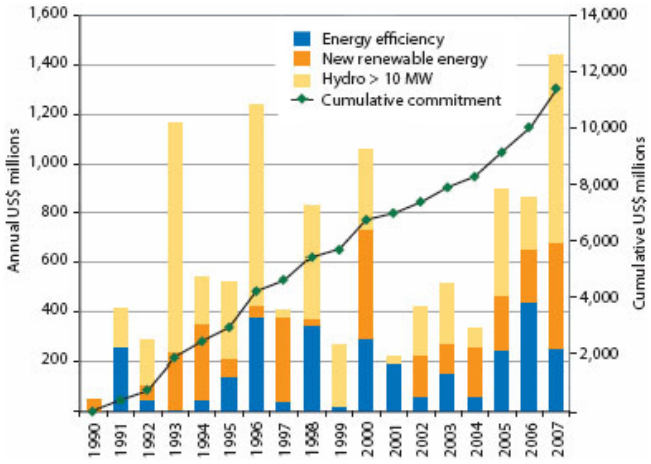

Fig. 5. World Bank Group funding for energy efficiency and renewable energy resources [9].

6. Available funding frameworks

The World Bank Carbon Finance Unit (CFU) uses money contributed by governments and companies in the Organization for Economic Cooperation and Development (OECD) countries to purchase project-based greenhouse gas emission reductions in developing countries and countries with economies in transition. The emission reductions are purchased through one of the CFU's carbon funds on behalf of the contributor, and within the framework of the Kyoto Protocol's Clean Development Mechanism (CDM) or Joint Implementation (JI). Ten carbon funds are currently accessible under these two mechanisms. Table 2 lists these funds and illustrates their scope and capital.

Carbon finance helps to increase the bankability of projects by adding an additional revenue stream in hard currency, which reduces the risks of commercial lending or grant finance. Thus, carbon finance provides a means of leveraging new private and public investment into projects that reduce greenhouse gas emissions, thereby mitigating climate change while contributing to sustainable development.

The World Bank-managed carbon funds include over 200 projects with an estimated reduction value of more than US$ 2.5 billion as of August 2007. The largest

Table 2
Carbon finance funds and their capital [9]

Fund name	Acronym	Scope	Capital (US$ million)
Prototype Carbon Fund	PCF	Green house gas emission reductions	180
Community Development Carbon Fund	CDCF	Community development with clean energy in developing countries	128.6
BioCarbon Fund Tranch 1	BioCF	Sequester or conserve carbon in forest and agro-ecosystems	53.8
Danish Carbon Fund	DCF	Purchases emissions reductions that generate potential credits under the CDM and JI mechanisms of Kyoto Protocol	75.4
Spanish Carbon Fund	SCF	Sustainable development of developing countries	220
Umbrella Carbon Facility Tranch 1	UCF	Pools funds from World Bank-managed carbon funds and other participants to purchase emission reductions	998.8
Netherland Clean Development Mechanism Facility	NCDMF	Projects in developing countries that generate potential credits under the CDM of Kyoto Protocol	?
Netherlands European Carbon Facility	NECF	Purchases emission reductions from JI projects in countries with economies in transition	?
Italian Carbon Fund	ICF	Supports the private and public sectors in Italy to participate in clean technology and carbon emission reductions.	155.6
BioCarbon Fund (BioCF) Trache 2	BioCF	Sequester or conserve carbon in forest and agro-ecosystems	36.1
Carbon fund for Europe	CFE	Jointly managed by the World Bank and the European Investment Bank to help the European countries to meet their commitments to the Kyoto Protocol and the European Union Emissions Trading Scheme (EU ETS)	50

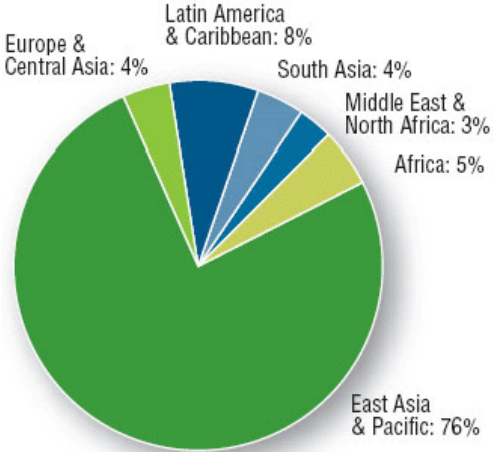

Fig. 6. Percentage share of the portfolio value of the World Bank-managed Carbon Funds by region [9].

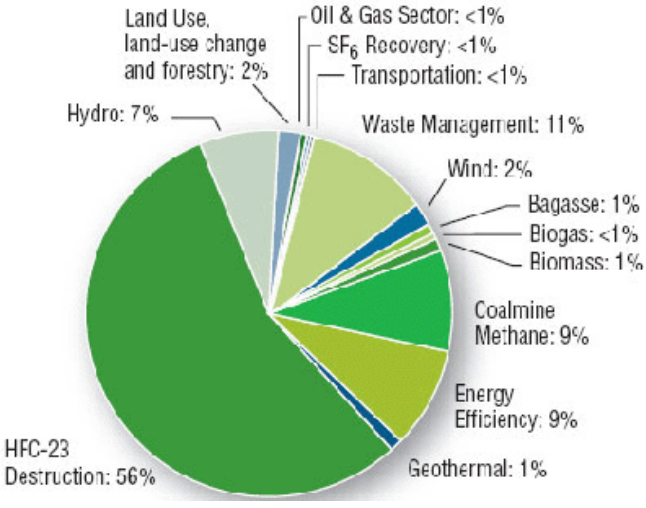

Fig. 7. Percentage share of the portfolio value of the World Bank-managed Carbon Funds by sector [9].

beneficiary is in East Asia and Pacific region (76%) while MENA's share is only 3% (Fig. 6). The Region can benefit from energy efficiency, gas flaring reduction, waste management, renewable energy utilization, biogas and trifluoromethane, HFC-23 management. The dominating area that benefits from the World Bank-managed CF is the HFC-23 destruction (Fig. 7).

7. Conclusions

In conclusion, desalination is playing and will continue to play a significant role to respond to the MENA region's growing water demands. The technology has been proven and is becoming less expensive. Integrated water resource management needs to be carefully implemented to determine the optimal combination of supplies to maximize the net benefit. The need for desalination is growing due to demand growth and expected adverse impact on the water resources due to climate change.

As a mitigation measure to climate change, the Kyoto Protocol called for greenhouse gas emission reductions. Since then around a dozen Carbon Finance funds were established. The World Bank has also established its Carbon Finance Unit to interface with these funds. As a result of the world commitment, the global carbon market grew to US$ 64 billion in 2007, doubling in value over the US $30 billion in 2006 and six times in value over the US $10 billion registered in 2005 [10].

References

[1] World Bank, Annual Report, 2007.
[2] FAO, AquaStat, 1998–2002.
[3] M. Belloumi, Desalination as an option to resolve problems of water scarcity in MENA Region, Second French Serbian Summer School Vrnjačka Banja, 2007.
[4] F.M. Doumani, Climate change adaptation in the water sector in the Middle East & North Africa region: A review of main issues, PAP/RAC Workshop, Sardinia, 2008.
[5] B.A. Hamilton, Public private partnership in the MENA water sector, Challenges and opportunities, OECD Conference on Public Private Partnership for Infrastructure Financing, Istanbul, Turkey, 2006.
[6] E. Remawi, Entrepreneurship as public policy: completing the ecosystem with technology venture capital, HCT–MIT Entrepreneurship Conference, Rio de Janeiro, Brazil, 2006.
[7] M. Balaban, Desalination in Maghreb, Euromed Conference on Desalination Strategies in South Mediterranean Countries, Tunisia, 2007.
[8] Global Warming Intelligence, Desalination Markets 2005–2015: A Global Assessment and Forecast, 1st ed., 2004.
[9] World Bank, Carbon finance for sustainable development, 2007.
[10] World Bank Institute, State and trends of the carbon market, 2008.