ASSESSMENT OF POTENTIAL CUMULATIVE ENVIRONMENTAL IMPACTS OF MEGA DESALINATION PLANTS CONGLOMERATING AROUND THE MEDITERRANEAN

UNDER THE PILLAR NON- CONVENTIONAL WATER RESOURCES

CONCEPT NOTE FOR SWM-SM 2ND SC

16 & 17 OCTOBER 2012, BRUSSELS

ACTIVITIES PROPOSED FOR 2013 PLAN OF ACTIONS

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I. PREAMBLE:

Water resources are heavily exploited in SWIM-SM Participating Countries (PCs), with rapid population growth, environmental degradation, climate change impacts; it is no longer possible to satisfy water demand by attempting to increase supply. It became evident that non-conventional water resources are an absolute necessity if countries are to bridge the gaps between supplies and demands. Further to plans for the full exploitation of treated wastewater reuse, desalination using RESs emerged as a techno-economically feasible option that needed further investigations.

Within such context, SWIM-SM developed and implemented its 2012 plan of action to include the following:

1. A review of the Best Available Technologies (BAT) suitable for countries of the region with an exclusive focus on desalination for rural areas. The main was to produce a report reviewing and compiling the BAT that can be catered to the specificity of countries of the region to supplement water supplies to remote communities either on the coastline or inland using Renewable Energy Systems (RESs).
2. Establishment of a Core Desalination Group (CDG). In an effort to ensure the quality and credibility of its views and orientation, SWIM-SM formed the CDG composed of internationally renowned experts to advise SWIM-SM with the involvement of National desalination experts on the validity and integrity of SWIM-SM produced reports and to suggest policies options to pave the way for a more sustainable desalination in the region.
3. Convened an Expert Group Meeting to review, discuss and validate the findings of SWIM-SM assessment on the subject, to advise SWIM-SM on state-of-the art development in the field of desalination using RESs and to discuss with SWIM-SM team and National desalination experts regional orientation towards desalination in addition to future activities in support of promoting sustainable desalination in the region.
4. Produced a report on the economic aspects of desalination entitled "Economic considerations for planning desalination in South Mediterranean Countries”. The report aimed at compiling information for raising awareness of decision makers in PCs on less expensive alternatives to desalination and developed a guideline to conceptually undertake an opportunity cost analysis prior to planning and deciding on desalination projects within a strategic IWRM framework.

II. REACTION TO STAKEHOLDERS RECOMMENDATIONS IN THE 2013 WORK PLAN:

Based on the outcomes of the assessment of desalination BAT undertaken during SWIM-SM 2012 activities, views and recommendations of the CDG in addition to priorities identified by national experts during the expert group meeting held in Athens on 12 & 13 of June 2012, SWIM-SM was able to reorient itself to address the real needs of its PCs in this domain in its future plan of actions for the year 2013. This reorientation was also designed to ensure continuity by taking stock from priorities indentified during fact finding missions, results and recommendations emanating from first year program implementation and through synergy with partner organizations dealing with the issue to guarantee complementarities. Furthermore, the opinion expressed by National Focal Points (NFPs) and EU Delegations (EU-Del) at the national level were considered in proposing the 2013 plan of actions to include desalination issues of concern to the region.

Within such a context, desalination was considered to be a part of a holistic approach for the overall sustainable development and only after less expensive technical efficiency (demand management interventions) & allocative efficiency (efficiency with which society allocates its water resources among sectors for sustainable socio-economic development) are totally exhausted. Water demand management options such as water conservation, reallocation among sectors, inter-basin transfer, changing crop patterns, innovative irrigation techniques, reduction of Non Revenue Water (NRW), etc. should be considered first.

The niche for SWIM-SM work on desalination was to mainly address desalination processes combined with Renewable Energy Systems (RES) for the water supply. As suggested during desalination experts meetings, the selected niche shouldn't exclude SWIM from addressing other desalination issues of priority to the region including environmental aspects of the industry at its different scales.

During the expert group meeting discussions, the potential cumulative environmental impacts of the proliferating mega desalination plants, around the shores lines of the Mediterranean, strongly emerged as a crucial issue that should be given adequate attention from SWIM-SM.

PROSPECTS OF DESALINATION IN THE MEDITERRANEAN REGION:

In order to address increasing water demands, SWIM-SM countries are resorting to sea water and/or brackish water desalination. The desalination industry is now developing very fast and proliferating equally around the North and South shorelines of the Mediterranean Sea.
Some countries in the region, particularly Israel, have helped in the reduction of the production cost of desalination. As experience and technology have developed, including through major investments, production costs for desalination have fallen dramatically. According to the World Bank, unit sizes have increased, bringing economies of scale. These advances have driven prices down from an average of US$1.0/ m^3 in 1999 to between US$ 0.50/m^3 and US$ 0.80/m^3 in 2004 (World Bank and BNWP 2004). Large plants can desalinate seawater for as little as US$ 0.44/m^3, although, in some cases, these costs may reflect distortions such as subsidized energy prices, soft loans, and free land.
In **Egypt** there are several desalination plants on the coasts of the Red Sea and the Mediterranean, which provide water for seaside resorts and hotels. Most are privately owned. However, a political decision was taken in 2010 to ban the transfer of any fresh water from the Nile valley to either the East or West of the country. All water demands in these vast areas shall be met by desalination.
Spain, with around 1500 operating plants and an installed capacity of over 2.5 million m^3 per day, ranks in the 4th position internationally.
Algeria commissioned 3 plants in Arzew, Algiers and Skikda, between 2006 and 2009, for a total capacity of 400,000 m^3 per day. It is envisioning a total capacity of 2.5 million cubic meters per day based on the construction of 12 new plants by the end of 2012.
In **Israel**, the Ashkelon plant has been producing 320,000 cubic meters per day since 2006 and covers the drinking water needs of over 1.4 million persons. The country pursues a desalination production growth target of covering at least 70% of the drinking water needs. Two desalination plants are under construction process in Sorek and Ashdod. Full output of the installations will be reached as from 2013 with a daily production of one million m^3.

In **Libya**, the strategic plan to promote water resources grants a privileged position to sea water desalination with the objective of installing, a total desalination capacity of 900,000 cubic meters per day by the end of 2012.

According to Plan Bleu (2010) the sea water desalination market in the Mediterranean is set for high growth in the coming years. By 2030 the Mediterranean region is projected to multiply its desalination capacity by threefold, or even fourfold, thus reaching 30 to 40 million m^3/day exceeding 12 billion m^3/year. Assuming a 50% recovery (typically between 35% - 60%), the production of such a volume of desalinated water will require pumping some 24 billion m^3/year of sea water and in turn discharging around 12 billion m^3/year of brine.

The cumulative environmental impacts associated with the construction and operation of such a large number of mega desalination facilities around the Mediterranean Sea have to be explored, assessed and analyzed by concerned institutions in the SWIM-SM region.

WHY THE CONCERN?

Assuming the lowest possible level of total residual chlorine of 0.2 mg/liter (typically between 0.2 and 0.5 mg/l) in the discharged brine water will result in the dumping of 2,400 metric tons of the extremely toxic residual chlorine in the near-shore marine environment on an annual basis (6.6 tons per day). Chlorine is quite toxic to marine biota if discharged to the environment without neutralization. According to US-EPA criteria (1986) indicate that, except possibly where a locally important species is very sensitive, saltwater aquatic organisms and their uses should not be affected unacceptably if the 4-day average concentration of chlorine - produced oxidants does not exceed **7.5 ug/L** more than once every 3 years on the average and if the one-hour average concentration does not exceed **13 ug/L** more than once every **3** years on the average.

More important are the cumulative impacts of trace metals in the near-shore marine sediment with all its potential bio-availability, bioaccumulation and biomagnifications in the food chain.

All desalination processes present some environmental drawbacks that include the following:

1. **Environmental Impacts of Plant's Intake:**

There are two types of intake effects associated with mega desalination operations. These are namely impingement effects and entrainment effects. As the seawater going into the power-desalination plant is screened and filtered, aquatic organisms are removed from water. This is called impingement effects. Entrainment effects take place when smaller organisms passing through filters find their way through the process where they get exposed to chemicals, higher temperature or pressure, conditions which are severe or even endangering their existence.

2. **Brine Disposal:**

Disposal of concentrated brine into the near-shore marine environment with insufficient dilution can impoverish or destroy water ecosystems and cause deterioration of water quality. The characteristics of the reject brine was found to be a direct function of the quality of the feed water, the desalination technology used, the percent recovery, the chemical additives used within the process, the construction material and proficiency of the operators.

Most of the mega desalination plants in the Mediterranean Region are located on the coastlines. They obviously discharge their brine concentrate into the adjacent near-shores. It is believed that rapid mixing and dilution are "keys" in reducing risks associated with disposal of brine in the sea. The risk magnitude of brine discharge depends to a large extent on the physical, chemical and biological characteristics and the assimilative capacity of the receiving near-shore marine environment.

The pollutants constituting the brine water discharged to the near-shore marine environment might be manifested in one or more of the following forms:

- Physical impact: Results from the discharge of hot brine from thermal desalination. In the life of marine organisms, temperature elevations from ambient values cause thermal stress that might result into an eco-toxicological effect such as disturbed enzyme activity, water balance and cellular chemistry.
- Chemical impact: Results from chemical agents remaining in the brine water and added within the process for the control of bio-fouling, control of scale formation and antifoaming agents.
  - The discharge of residual chlorine even at very low fraction of one part per million (ppm) levels is posing a real risk to the near-shore marine environment particularly to fish and invertebrates that were found to be more sensitive to residual chlorine oxidants than

aquatic plants. Given these facts, it appears that the discharge of trace levels of residual chlorine oxidants either in open or enclosed seawaters is posing serious risks to aquatic life in the near-shore marine environment.

- In thermal desalination plants, it is plausible to find corrosion products in brine waters resulting from the effect of water flow, dissolved gases and treatment chemicals (acids) on the alloys utilized in the construction of desalination pipes and equipment's. The corrosion products may include harmful heavy metals such as Nickel (Ni), Copper (Cu) and Molybdenum (Mo) and less toxic metals such as Iron (Fe) and Zinc (Zn).
- As conservative pollutants, metals will last and accumulate in different compartments of the marine environment forever. However, their ultimate sink is the marine sediment.
- The chemical analysis of seawater indicates that scale such as alkaline scale can form in the desalination plants. These scales occur when the bicarbonate ion breaks down by heating. In order to control calcium carbonate scaling, concentrated sulfuric acid is added to the feed water to remove the bicarbonate ions. Furthermore, threshold scale inhibitor such as mixtures of sodium hexametaphosphate and surface active agents like lignin sulphonic acid derivatives and esters of polyalkyl glycols are added in desalination plants to hamper the growth of carbonate and/or sulfate crystals.
- The formation of THMs in brine water is a direct consequence of the chlorination process in which free chlorine reacts with the natural organics occurring in seawater and other organic pollutants acting as precursors to form THMs. Some of the volatile THMs species were found to be mutagenic to humans and harmful to seafood. Brominated species dominates the formation distribution, with Bromoform (CHBr3) accounting for more than 90% of the total THMs.

- Biological impact: Is the secondary effect of oxygen demand exerted by the natural and induced organics in the brine-water. Relatively higher levels of Biochemical Oxygen Demand (BOD) and lower Dissolved Oxygen (DO) might be observed in the desalination plant effluents.

3. **Atmospheric Emissions:**

Thermal desalination and to a much less extent RO require intensive thermal or electrical energy through steam electric generating plants designed to burn crude oil, gas-oil or heavy fuel oil. The products of combustion most commonly released by fossil fuel are ash particles, carbon dioxide (CO_2), carbon monoxide (CO), water vapor, Sulfur dioxide (SO_2), and nitrogen oxides (NOx). The main concern is on the Green House Gases (GHGs) emissions and the potential formation of acid rain.

III. OBJECTIVES OF PROPOSED DESALINATION ACTIVITIES FOR 2013.

The fast proliferation of mega desalination plants around the Mediterranean Basin in Israel, Algeria, Spain, Cyprus, etc and the ambitious plans for the construction of additional mega plants in Egypt, Morocco, Ghaza strip, etc. is raising serious concerns about their potential cumulative environmental impacts on the near-shore marine environment. Based on these speculations and on the recommendations of the CDG and national desalination experts, SWIM-SM shall undertake in collaboration with MED-POL a survey on existing and planned mega desalination projects around the Mediterranean basin with the view of assessing the potential cumulative environmental impacts on the near-shore marine environment.

The overarching objective of the desalination activities proposed for the year 2013 is to investigate and conceptually assess the cumulative environmental impacts of mega desalination plants conglomerating around the shores lines of the Mediterranean and to identify their mitigation measures.

IV. PROPOSED ACTIVITIES:

In order to materialize the abovementioned objective, SWIM-SM is proposing to undertake the following activities:

1. **Assess potential cumulative environmental impacts of mega desalination plants conglomerating around the Mediterranean in synergy with MED-POL. (2013)**

The assessment shall encompass the following:

- An inventory of the currently operating mega desalination plants including the technical details such as technology used, production capacity, pre-treatment, energy used, chemicals consumed, etc.
- A survey of mega desalination plants in pipeline or planned until 2030 on the shores of the Mediterranean Basin.
- An assessment of the brine discharge in terms of volume, pollution load, physical and chemical characteristics, etc.
- An assessment of atmospheric emissions including SO_2, CO_2, particulates, NOx, etc.
- A conceptual assessment of the potential fate, transport, bio-accumulation and bio-magnification of desalination related contaminants.
- A projection of the cumulative impacts of brine discharges on the marine eco-system and assessment of potential impacts on food chain and bio-diversity using variable scenarios.

2. **Convene a regional Expert Group Meeting including the members of Desalination Core group in Athens on Potential Cumulative Environmental Impacts of Desalination Plants on the Mediterranean Sea to substantiate and verify the outcomes the above assessment. This activity will be implemented in synergy with UNEP-MAP, MED-POL, H2020. (2013)**

3. **Convene a one-day high-level techno-political policy dialogue in Brussels to develop a vision and debate the prospects of desalination on the Mediterranean Sea in light of expert's opinion on its potential cumulative environmental impacts in collaboration with MED-POL, EDB, UfM. To be implemented during (2014).**

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