



## TABLE OF CONTENTS

	Page No.
Report	1- 13
Annex I: List of participants	
Annex II: Agenda	
Annex III Conclusions and recommendations of the Experts meeting on environmentally sound management of sea water desalination plants and brine discharges	

## Introduction

1. In view of the envisaged increase in the number of seawater desalination plants in the Mediterranean region, and their possible detrimental effects on the environment, the 12<sup>th</sup> Ordinary Meeting of the Contracting Parties to the Barcelona Convention, held in Monaco in November 2001, adopted a recommendation calling upon the Secretariat to prepare guidelines for the management of brine discharged from seawater desalination plants. The MED POL Programme, in cooperation with the municipality of Forlì and the association Amici per la Vita, therefore organized a meeting of Government designated experts in the Salone Comunale, Forlì, Italy, on 16-18 May 2002, to review seawater desalination activities in the Mediterranean region and their possible environmental effects, and to elaborate specific guidelines for the adequate management of desalination plants. The Meeting was organized with the support of the Italian Ministry of the Environment, the Province of Forlì-Cesena, the Emilia Romagna Region and the National Association of Italian Communes (ANCI) and Arpa Emilia Romagna. Support was also provided by the Centro Ricerche Marine of Cesenatico, Unica, Romagna Acque, Efeso Scarl Legacoop e Trascoop Group.

## Participants

2. The list of participants is attached as Annex I to this report.

### Agenda item 1. Opening of the Meeting

3. The Meeting was opened at 9.30 a.m. on 16 May 2002 by Mr Franco Rusticali, Mayor of the Commune of Forlì, who welcomed all the participants. He recalled that the problems affecting the Mediterranean Sea were well known and included the toxic substances flowing into the sea from rivers, coastal erosion, the unregulated increase in consumption, waste discharges from oil tankers, the impoverishment of biological resources and the often unbalanced development of tourist resorts. As the mayor of a medium-sized city situated only 30 kilometres from the coast, in the same way as those responsible for the administration of thousands of other cities, both small and large, he was dedicated to safeguarding this natural heritage and major economic resource. Indeed, in an era of globalization, local communities formed a vital link in the chain for the application of the measures decided upon at the national and regional levels. Mayors of communities such as Forlì had an important role to play in ensuring the application of legal rules and in the promotion of attitudes and life styles which respected the ecosystem. The relationship between economic development and the quality of life was therefore a major component of the policy of sustainable development that local authorities needed to pursue as a basis for their reforms.

4. He described the situation of Forlì, which was located in a region with a high concentration of industrial, artisanal and agricultural activities. The problem of water resources and their integrated use had been addressed through major public works, which were among the most advanced in Europe. For the past 20 years, the company "Romagna Acque" had been managing a canal cut through the mountains with a capacity of 30 million m<sup>3</sup> of high quality drinking water for distribution to over 40 communes in the region. Water for industrial and particularly agricultural use was provided by another canal connected to the river Po. The major concern in this respect, rather than the provision of water resources, was the reduction of pollutants in the air, water and soil. The major efforts made in this field included the thermal treatment of solid urban wastes in a plant with a capacity of 200 tonnes a day, with an advanced system for the treatment of the smoke produced during combustion. Efforts were currently being focussed on improving sewage and waste water treatment systems, particularly with a view to reducing discharges of phosphates and nitrates, which were the principal causes of eutrophication and the threat to bathing waters. He also drew attention to the recently adopted plan for energy saving, including the first cogeneration plant for the combined production of heat and electricity. These were all practical measures intended to promote a culture of cooperation and peace based on mutual respect as a basis

for safeguarding the heritage to be left to new generations, who would live in a globalized world of ever greater interdependence between areas and regions. The global economy could serve the causes of life, health and survival. However, if the global market was not equitable and did not adopt the approaches of sustainable development and more balanced consumption, it also had the potential to destroy humanity and the environment. He therefore urged the participants to do their utmost to produce guidance for the future so that all Mediterranean countries could take effective action to safeguard the environment and its fundamental resources.

5. Mr Guido Tampiere, Responsible for Agriculture, Environment and Sustainable Development for the Emilia Romagna Region, emphasized that his region had adopted the policy objective of managing the environment with a view to improving the quality of development and the social well-being of those who lived in the region. In order to take action on the three global challenges of food, water and air, which could not be ignored, it was necessary to improve motivation and provide society with objectives and instruments. Although the water problem was dramatic in some countries, perception of its importance in countries that were not directly affected by water shortages was low. The patterns of water use were often wasteful and polluting, with the volume used rising as social and economic well-being improved. Although awareness of the problem was increasing, particularly in areas, such as Emilia Romagna, where the sea was of great economic importance, progress was still slow and it was necessary to accelerate programmes, resources and measures. The idea of a clean Mediterranean had remained an unachievable utopia for too long. It was now necessary to give credence to the idea that the problems involved could be tackled. In this respect, the Strategic Action Plan on persistent organic pollutants was beginning to provide a focus for aspirations and should be fully supported.

6. He added that Forlì lay at the centre of a highly vulnerable coastal system on an almost closed sea, subject to the pressure of one of the most advanced economic areas in Europe. A systematic and integrated approach to its management was therefore required, covering all the aspects of shared water resources, transport, tourism, fishing and the whole coastal economy. A culture needed to be developed which recognized the interdependence of all the various processes and which was based on the mutual sharing of responsibilities. This culture had to be based on a new concept of citizenship and of belonging built on awareness and communication which went beyond a particular group, area or language. Society was still at the stage of the race for consumption, and policies based on the principles of sustainable development were slow to prevail. Change was therefore needed in land-use planning and in patterns of production and consumption. In particular, integrated plans were needed for the management of water and of the coast. Water policy had to address the qualitative and quantitative aspects of water conservation and the prevention of pollution. He recalled in this respect that great progress had been achieved in waste water treatment in Emilia Romagna, where all coastal waste water was treated. The benefits for the coast had been immediate. However, the quality of water in the Adriatic depended largely on the discharges from the Po and the policies adopted throughout the Po basin. He therefore welcomed the judicial sentence condemning the Commune of Milan for its inadequate water treatment system. There was no room in the rich Po basin for policy shortcomings in this field. The plan for the integrated management of the coastal area, developed in accordance with European Union recommendations, would be designed to promote economic and environmental sustainability in the long term. It would focus on geology, hydrology and saline discharges; the management of the water resources in the basin; port facilities and maritime transport; sustainable tourism; fishing and aquaculture; agriculture; the management of natural habitats; coastal urbanization; and transport and energy policies. The success of the policy depended on the collaboration between institutions, based on voluntary action and full shared responsibility, and constituted a real challenge for the public administration.

7. Mr Piero Gallina, President of the Province of Forlì-Cesena, emphasized that the Mediterranean Sea was undoubtedly the cradle of Western civilization. Historically, it was a

sea of cultural exchanges requiring the sharing of responsibilities and roles. The issue of marine pollution from land-based sources was of great importance in an area located on the Adriatic coast and which depended on the sea for an important part of its economic resources. While the factors which gave rise to algal blooms on the coast were now known (and particularly meteorological conditions resulting in a high level of stratification of the water column and the increased availability of phosphates and nitrates discharged into the sea following rainfall), those setting off the phenomenon of mucilage were not yet clearly understood. An important factor was undoubtedly the pollution arising from the fact that half of the global maritime transport of oil passed through the Mediterranean. He warned that when phenomena occurred which modified the marine environment, even temporarily, the coastal system entered a crisis which affected both tourism and the fishing industry. The situation in the latter industry was also aggravated by over-fishing, which contributed to the vicious circle of the impoverishment of marine resources.

8. The problems of eutrophication and the decline in marine resources had led to the establishment of the Marine Research Centre of Cesenatico which, with the support of the oceanographic research vessel "Daphne", was the scientific focus of continuous monitoring in the Adriatic. Over the years, the Centre had developed considerable experience and multi-year data series. He added that, in the knowledge that action to combat marine pollution needed to be taken on land, the State and the local authorities had taken measures to identify and reduce the discharge of nutrients, and particularly phosphates and nitrates, which were the main causes of eutrophication. These measures included the adoption of legislation requiring removal of polyphosphates from detergents; initiatives to reduce the use of fertilizers and pesticides in agriculture through the adoption of integrated and organic production methods; the development of standards for the adoption of agricultural best practices, thereby contributing to reducing the volumes of nutrients in the soil; and the widespread development at the local level of systems for the collection and treatment of urban waste water. Measures of this latter type would need to be expanded, notwithstanding their high cost. As a result of this action, the quality of water in rivers and the Adriatic had undoubtedly been improved. This was due in large part to greater awareness by society and the development of the appropriate culture among consumers, farmers and producers in general. Indeed, the development of action by local authorities for the implementation of the prescribed rules had resulted in the conclusion of voluntary agreements with companies designed to increase individual responsibility and to identify and control current and future risks. In return, the companies enjoyed an enhanced public image and closer relations with the authorities, as well as better possibilities of gaining access to public funding. He concluded that the principal problem lay not so much in the adoption of standards and rules, as in the development of a culture of environmental conservation and an awareness that development could go hand in hand with the sound management of natural resources. It was of particular importance in this respect to develop the culture and practice of sustainable tourism, since tourism was a major source of environmental pressure.

9. Mr Aldo Iacomelli, Ministry for the Environment of Italy, after thanking all those involved in the organization of the meeting, and particularly the Mayor of Forlì and Amici per la Vita, recalled that water was one of the pillars of the forthcoming World Summit on Social Development, to be held in Johannesburg in September 2002. He emphasized that safe and easy access to water was a right for everyone. The importance of this right was highlighted by the current difficulties experienced in Sicily in the provision of water, and the risk of a serious crisis there over the summer. It was important for everyone around the Mediterranean to learn the lessons from the past concerning the traditional use of water, and at the same time to adopt the added value of appropriate technology to help improve water management. For example, the difficulties experienced in Sicily were in large part due to the problems encountered in the distribution of water, with some two-thirds of the total water supply in the region being lost during distribution. It was important for all major users of water, including agriculture, industry and services, to examine how better use could be made of this precious resource. In view of the difficulties involved, it was essential to develop a

common policy for water use, involving its integrated management insofar as possible. The search for new sources of water, for example through desalination, should therefore be accompanied by measures such as the recycling of water for certain uses. In this respect, three points should be borne in mind: the need to adopt new techniques to manage the use, recycling and treatment of water; the utilization of continuous reaction techniques using the sun as a source of energy for desalination, rather than batch reaction techniques, thereby avoiding the creation of large amounts of sludge; and the development of new financial arrangements to fund the supply of water. He emphasized that it was no longer possible to avoid the subject of the pricing of water, particularly where big users were concerned. Finally, he informed the participants that his country had decided to set up a trust fund, consisting of one or two million euros a year, to be managed by UNEP/MAP, to finance practical activities in the field of water treatment using sustainable sources of energy.

10. Mr Attilio Rinaldi, Emilia Romagna Regional Prevention and Environmental Protection Agency, described the structure and operations of the Agency, with particular reference to the monitoring activities carried out by the oceanographic section since 1977 and the large amount of data which had now been accumulated for analysis. He emphasized that the environmental problems of the Adriatic Sea and its enormous social and economic importance made it one of the great environmental paradoxes of the country. The emergence in the 1970s and 80s of the phenomenon of acute eutrophication had led to the adoption of major measures designed to achieve, among other objectives, a reduction in the levels of nutrients, and particularly those of phosphates in detergents, the improvement of coastal wastewater treatment plants and changes in agricultural production to promote the rational use of fertilizers. These steps had resulted in a significant improvement in the situation over recent years, although the success had only been partial in view of the need for global action covering the whole of the Po basin, including action to resolve the ongoing problem of waste treatment in Milan. In addition to the issue of the quality of bathing waters and the more general requirement to improve the environmental situation in the Adriatic, another important threat consisted of coastal erosion. This required far-reaching analysis of the successes and limits of the strategies adopted up to the present with a view to the identification of more effective techniques with a lower impact on the coast and on marine resources. Although fishing and aquaculture were not perhaps of major economic importance in national terms, they were of great local significance and could be of great benefit in promoting conservation. Moreover, at a time when greater attention was being paid to the quality and safety of food products, it was not widely realized that a large proportion of the marine products that were consumed by humans had their origins in intensive production. This raised the issue of the conditions under which they were produced and the food provided to them, which were not always of the highest quality, as seen for example in the case of "mad cow disease", etc. Action to promote the responsible use of resources should therefore be accompanied by policies to prevent coastal pollution and improve the conditions for the intensive production of marine resources. He emphasized that it was near to the coast that the highest levels of biodiversity were to be found in the marine environment, where most marine fauna reproduced and where the levels of biological production were the highest. Coastal areas were therefore very sensitive and the future of the sea depended on them. It was therefore especially necessary to develop cooperation between all the partners concerned in the Adriatic basin, including those responsible for the quality of water in rivers, as well as to promote closer cooperation between countries.

11. Ms Silvia Bernardini, National Association for Italian Communes (ANCI), said that only a few years ago it had seemed almost impossible that representatives of local authorities and of European and Mediterranean Governments would be meeting together to find common solutions to the problems affecting all countries equally. However, ANCI had always believed that it was of great importance to achieve such multi-level collaboration and the presence at this meeting of the municipality of Forlì, representing in its turn all the communes of Italy, was therefore the symbol of an objective which had been achieved. She added that the events of the past few days in Sicily showed just how serious the problem of

access to water had become. And if access to water had taken on the tone of an emergency in a so-called modern country such as Italy, where the problem could easily be resolved through the sound use and rationalization of existing water resources, how much more serious the problem must be in countries where the geographical and climatic conditions made water a rare treasure. She hoped that the meeting would be instrumental in achieving progress towards a real solution to this grave problem before water conflicts grew in importance and took on the dimension of real wars. The experts brought together in the meeting had an important role to play in identifying the policies and techniques to be applied so that this precious resource could be managed in the best possible way. It would then be for the politicians and public authorities to achieve the objectives agreed upon by engaging in further dialogue with all the actors concerned. In conclusion, she gave thanks to all those who had collaborated in the organization of the meeting, including Amici per la Vita and the city of Forlì.

12. Mr Sergio Illuminato, Amici per la Vita, emphasized the symbolism of an international environmental meeting being held for first time in the chamber of a municipal council, which played such an important role in the implementation in practice of the rules and policies adopted elsewhere. When Amici per la Vita had first started its work of promoting international agreement on common environmental problems in the Mediterranean, in collaboration with UNEP/MAP, it had enjoyed very little support from the Italian Ministry of the Environment, and none at all from regional bodies. Twelve years later, the fact that the next Meeting of the Contracting Parties of the Barcelona Convention would be hosted by Catania showed how involved local communities had become in environmental issues. This development marked the growing realization of the importance of public information and the involvement of all the stakeholders at the international, national and local levels in partnerships to achieve environmental goals. In conclusion, he thanked all those who had collaborated in organizing the present meeting and had offered their support to it.

13. Mr Saverio Civili, UNEP/MAP, expressed appreciation for the great efforts made by the city of Forlì, the Province of Forlì-Cesena and the Emilia Romagna Region in organizing the meeting and for the attention that they were paying to environmental problems and water management. In this respect, they provided a very good example to be followed by the rest of Italy and by other countries. He emphasized the great importance of water resource management, which was a subject with tremendous economic, social and environmental implications. Desalination was an increasingly important aspect of this, with clear environmental and other implications. He therefore hoped that the meeting would be able to provide a basis for the preparation by MAP of guidelines on this subject. Finally, he welcomed the fact that the meeting was being held in the chamber of a municipal council and emphasized the importance of the role played by such local authorities and their downstream responsibilities, particularly in the field of water management.

## **Agenda item 2. Election of Officers**

14. The meeting elected the following Officers:

Chairperson:	Mr Aldo Iacomelli (Italy)
Vice-Chairpersons:	Mr Louis Vella (Malta)
	Mr Loizos Loizides (Cyprus)
Rapporteur:	Mr Fouad El Shibini (Egypt)

**Agenda item 3. Adoption of the Agenda and organization of work**

15. The meeting adopted the Agenda as proposed in document UNEP(DEC)/MED WG.205/2 which is attached as Annex II to this report. It agreed that presentations by experts on the management of desalination plants in the Mediterranean would be heard in plenary and that the meeting would then form two working groups to discuss the legal and policy aspects and the technical aspects of the subject, respectively.

**Agenda item 4. Scope and purpose of the Meeting**

16. Mr Civili indicated that while broader water management issues were normally addressed by organizations other than MAP and its MEDPOL Programme, the revised LBS and Dumping Protocols to the Barcelona Convention brought issues such as the dumping and discharge of brine from desalination plants within the purview of the Barcelona Convention. Several countries had therefore suggested that MAP should investigate the possibility of developing guidance on the design and management of desalination plants in the Mediterranean, with particular reference to any associated environmental problems. The meeting was therefore called upon to review the assessment of seawater desalination plants made in document UNEP(DEC)/MED WG. 205/3, to indicate whether guidelines on the planning and management of seawater desalination plants in the Mediterranean were needed and, if so, to propose some elements as a basis for the preparation of such guidance by the Secretariat, based where appropriate on the Recommendations for the preparation of guidelines for the environmental sound management of sea water desalination in the Mediterranean region contained in document UNEP(DEC)/MED WG. 205/4.

17. The Chairperson added that the purpose of holding the meeting was to examine the issues raised by the design and operation of seawater desalination plants, with particular reference to brine discharges, within the broader context of MAP's focus on the reduction and elimination of persistent pollutants in the Mediterranean. In doing so, he emphasized the importance of a number of key issues. These included water pricing, in view of the need to develop mechanisms to finance the treatment and distribution of water. However, since access to water was a right, its price could not be high. Perhaps a higher price could be charged to those who obtained added value from the use of large quantities of water. It would also be necessary for the meeting to develop a policy vision placing desalination within an overall approach to water demand management which also included improving the efficiency of distribution networks, the adoption of best available technology, the use of pumping and a review of water use in agriculture. The meeting would then need to focus on the practical and technical issues raised by desalination.

**Agenda item 5. Discussion and recommendations for the management of desalination plants in the Mediterranean**

18. The meeting heard three presentations on the operation of seawater desalination plants.

*An overview of seawater desalination and the impact of brine on the marine environment in the Gulf region*

19. Dr Mahmoud Abdel-Jawad, Kuwait Institute for Scientific Research, emphasized at the outset that although access to water was a right for everyone, water had to be produced, treated and transported, which posed particular problems in areas where it was in short supply. It therefore became a commodity which needed to be paid for, either by the government or the consumer. He explained that there was a huge shortage of fresh water in the Gulf region, where the conditions were very arid and the aquifers were very limited and deep. However, the region had long seashores and plenty of energy resources, in the form of oil. He reviewed the development of desalination capacity in the Gulf region over recent

decades and noted that three of the four countries in the world with the highest installed capacities for seawater desalination were located in the region, namely Saudi Arabia, United Arab Emirates and Kuwait. While water demand in the region had increased, and was projected to increase still further in the domestic and industrial sectors, the main rise would be in the agricultural sector. He said that over the past 15 years the increased capacity of desalination units in the region, better energy utilization, improvements in materials and construction techniques and refinements in operation and engineering practices had all contributed to improvements in the overall performance of the plants and a reduction in the unit cost of desalinated water. As desalination was a reliable process and was affordable, in view of the availability of oil, desalinated water would continue to be the main source of freshwater in Gulf Cooperation Council (GCC) countries.

20. He added that current concerns with regard to the Gulf marine environment stemmed from a range of areas, including desalination activities, power generation, rapid urbanization, industrial development, oil production and processing, fishing and recreational activities. Desalination plants all produced brine to be discharged into the sea. After reviewing the desalination techniques used by the various GCC countries and the volumes of brine discharged, he focused on the impact of seawater desalination and power generation operations on the marine environment in Kuwait. Indicating the characteristics of seawater in the Gulf, he noted that the circulation residence times, at between two and five years, were sluggish, and that the evaporation rate was very high, particularly in view of the very high temperatures in the area. Kuwait had eight dual purpose plants for the desalination of seawater and the production of electrical power along its 120 km coastline. In terms of environmental considerations, he indicated that, in addition to impacts during construction, the principal operational impacts consisted of chemical pollution, thermal pollution and changes in the marine biota. Providing figures for the brine discharge of the dual purpose plant in Doha, and comparing them to the natural rate of evaporation of seawater, he concluded that in overall terms the operation of the plant had an insignificant effect on salinity in Gulf waters, even though the effects were not necessarily insignificant in very local waters. The impacts of the discharge of chlorine were also minor to insignificant. With regard to the antiscalants and antifoams used, he said that the addition of polyphosphates gave rise to the discharge of orthophosphates into the sea, which had environmental impacts. However, when these were replaced by polymeric additives, which were discharged as non-toxic and biodegradable substances, no environmental impacts were expected. He added that low concentrations of copper, nickel, chromium and iron were discharged into the sea with the brine, but that their levels were so low that the impact was also insignificant. One area in which desalination activities could have an impact was in relation to the temperature of the discharged brine, which was higher than the ambient seawater temperature. By promoting biological activity, localized lethal to sub-lethal impacts could occur for short periods in August and September, although these could be minimized by discharging the brine further offshore.

21. In conclusion, he indicated that seawater desalination and power generation activities had minor impacts on the ecosystem, provided that the construction of the plants was based on properly conducted studies for their design and operation. The production of vital commodities, namely water and electricity, outweighed the minor impacts associated with such activities. Water desalination and power generation were among the cleanest of chemical industries, provided they were based on effective studies to ensure that their pollution impacts were effectively minimized.

22. In the discussion that followed this presentation, after thanking Mr Abdel-Jawad, several speakers pointed out that conditions differed between the Gulf and the Mediterranean Sea and that experience of desalination in the GCC might not therefore be directly applicable to the Mediterranean. The differences included the lower volumes of cheap energy in the Mediterranean, the numbers of protected areas (including Posidonia meadows), water temperature (including the temperature at which biological activity thrives,

which was probably lower in the Mediterranean), salinity and the extremely long residence time of Mediterranean waters. It was likely that much of the Mediterranean flora and fauna was more sensitive to salinity than that of the Gulf. However, all the speakers agreed that desalination capacity in Mediterranean countries would undoubtedly rise in the future, both for seawater and for brackish water inland, since there were many cases of aquifers becoming saline. One speaker added that greater attention should be paid to technical innovations, such as the use of solar energy for the purposes of desalination and the possible uses to which brine discharges could be put.

23. In response to questions raised from the floor, Mr Abdel-Jawad emphasized that it was not his intention to claim that there were no problems inherent in the desalination process. However, with careful design, based on adequate studies to minimize their biological and environmental impacts, these problems could largely be overcome, particularly in dual use plants producing both electrical power and desalinated water. Furthermore, it should not be forgotten that the water produced in desalination plants was a food. In Kuwait, any chemicals used, such as polymeric additives, therefore had to be approved by the food and drug authority. Although he had provided data on toxicity tests in his presentation, he agreed that further long-term tests needed to be undertaken to ascertain the effects of desalination plants on the ecosystem. He indicated that few mistakes had been made in Kuwait in the design of desalination plants. One of the lessons learnt, however, consisted of the need to avoid discharging brine near to the shore, where the effects could be much more serious than further offshore.

24. Concluding the debate on this presentation, the Chairperson urged the meeting to look carefully at all the economic, social and environmental impacts of desalination operations with a view to identifying the best available techniques for the Mediterranean region. It would also be necessary to examine the financial aspects of the question, always bearing in mind that water was essential to life. Research might well need to be undertaken, and the necessary funds sought, possibly from the European Union, on these and related subjects, including the best ways of upgrading old desalination plants and, where possible, the potential uses of brine discharges. It would also be necessary in the meeting's recommendations to take into account the provisions of the amended LBS and dumping Protocols.

*Seawater desalination in the Mediterranean Region: Impacts of brine and chemical discharges on the marine environment*

25. Ms Sabine Lattemann, University of Oldenburg and ARSU GmbH Oldenburg, outlined the requirements for an environmental impact assessment (EIA) for desalination plants. Aspects that should be considered in an EIA are the chemical and physical properties of the desalination effluent, their effects on the environment, the sensitivity of the impacted ecosystem and mitigation methods to reduce impacts. She recalled that the reverse osmosis (RO) and multi-stage flash (MSF) distillation processes accounted for some 80 per cent of desalination capacity in Mediterranean countries. Both techniques required pre-treatment of the water intake, in the first case to avoid damage to the membranes and in the second to prevent for example corrosion. Pretreatment chemicals are partly alike due to the nature of seawater but also depend on the type of process. Their residuals and reaction by-products are present in the desalination effluents. Both types of operation involved the use of antiscalants and chlorine. Oxygen scavengers, corrosion inhibitors and antifoaming agents are typical pretreatment chemicals in the MSF process, whereas coagulants are used in RO plants only. She explained that the salinity of the brine produced by the RO method was higher than in the MSF method, although the discharges from the MSF method involved thermal pollution, as well as containing higher levels of chlorine and copper. She reviewed the toxicity and potential impacts of the main pollutants discharged during the desalination process. The use of polyphosphates as antiscalants raised the possibility of eutrophication. However, polyphosphates had now largely been replaced by new polymers, which had a

very low toxicity and decreased the risk of eutrophication. The levels of chlorination required for the MSF process were more problematic. The residual levels of chlorine in the discharge were highly toxic to many species and therefore required a mitigation procedure. Moreover, mitigation methods are necessary to reduce corrosion and heavy metal contamination, e.g. through improved process control or the replacement of copper-nickel heat exchangers with new materials like titanium. The copper discharged in the MSF process also gave rise to risks. She provided a series of figures to provide a rough estimate of the loads of copper currently discharged into the Mediterranean Sea. At a very conservative estimate, some 9.3 tonnes of copper were discharged each year as a result of MSF desalination, which could be compared with 93 tonnes a year discharged by the Rhone and 80 tonnes by the Po. In summary, she concluded that the RO process was less problematic in environmental terms during the phase of normal plant operation than MSF distillation plants, where the principal problems consisted of the chlorine present in the brine, the halogenated organics, copper contamination and the high temperature of the brine. In contrast, plant cleaning was more problematic for RO than for MSF plants.

26. Turning to the issue of the sensitivity of the various types of coastal ecosystems to desalination operations, she indicated that the types of coastline with the lowest sensitivity consisted of high energy coasts, where there was a high level of water exchange and sediment mobility, leading to a lower pollutant residence time. The most sensitive areas consisted of seaweed bays, coral reefs, saltmarshes and mangrove flats, where biological productivity and diversity was high, which were important for recruitment and as feeding grounds, and where there was a general sensitivity of the inhabitant species and endangered habitats. For impact mitigation, it is important to reduce the need for pretreatment chemicals, e.g. by locating intakes in deep water offshore, where concentrations of suspended material, dissolved organics and the numbers of biofouling organisms were low. Discharges should be located in exposed areas far from sensitive habitats. Modelling exercises should be undertaken to identify the plume spreading and chemical dispersal properties, and identify the ecosystems in reach, with a view to reducing the risk of acute toxic effects and the accumulation of pollutants. Finally, she reviewed the various mitigation methods available, before concluding that desalination was a well-established industry in the Mediterranean, although desalination capacity was still low compared to other regional seas. Desalination represented a tolerable risk to the Mediterranean marine environment and its impacts were probably restricted to a close distance from the plant. However, it should constantly be borne in mind that the capacities of a closed sea such as the Mediterranean were different from those of many other seas of similar sizes.

27. In the discussion that followed, many speakers thanked Ms Lattemann for a very interesting and thorough explanation of the impacts of desalination. In response to questions from the floor, Ms Lattemann explained that much of the data in her presentation had been taken from a book manuscript about EIA of desalination plants ("Seawater Desalination – Impacts of Brine and Chemical Discharge on the Marine Environment", in print by Desalination Publications). The information therein is based on literature research, including for example toxicity records from an environmental database published by the United States Government. The indications on site sensitivity were drawn largely from available literature on the dispersal of oil pollution. A brief discussion was also held on how high the temperature needed to be for the plume density of brine discharges from MSF plants to become positively buoyant and it was concluded that the salinity and temperature of water in the Mediterranean made it unlikely that the plume would be other than negatively buoyant. One speaker concluded that the presentation had been very enlightening, but had also shown the great need for reliable monitoring systems and for agreement to be reached on common practices and standards applicable to all those who lived and depended on the Mediterranean.

*Seawater desalination activities in the Mediterranean region and assessment of their environmental impacts*

28. Mr Loizides, Cyprus, recalled that water resources in the Mediterranean region were generally limited, fragile and threatened and that the lengthy dry season meant that there was a low average annual rainfall, thereby giving rise to the need for seawater desalination in the region. This need would become more pressing as the population continued to grow, which would have a major impact on the ratio of water demand to water resources. Briefly reviewing the desalination methods used in the region, he noted that hybrid and dual purpose co-generation plants permitted energy savings. For example, where RO plants used the exhaust steam from power generation there could be a consequent reduction in energy demand of between 10 and 15 per cent. Using transparencies, Mr Loizides provided graphs illustrating the desalination capacities of the various Mediterranean countries, the techniques used in each country and the main sectors which used desalinated water by country. He also provided graphs showing the growth of total seawater desalination capacity in the Mediterranean and the total volume for each of the desalination techniques used. Until the early 1980s, the main technique employed had been MSF distillation. Since then, most new plants had adopted the RO technique.

29. In the final part of his presentation, Mr Loizides focused on the environmental impacts of seawater desalination, with particular reference to the marine environment. Based on a summary of the pre- and post-treatment processes employed during potable water production by desalination, he analysed the adverse environmental impacts associated with the desalination process and expressed the view that the RO technique was clearly less environmentally harmful than MSF distillation. There nevertheless remained problems to be resolved with regard to the content of the water effluent and the discharge of toxic materials. He concluded his presentation by showing a number of photographs of the brine outfall for the Dhekelia desalination plant in Cyprus. These showed that the discharges from the outfall had destroyed the fauna within a radius of 100 meters of the outfall. However, the impact of the discharges was minimal at a distance of 250 meters from the outfall, and the situation became normal beyond 300 meters from the outfall.

30. In a short discussion following this presentation, emphasis was placed on the need to improve the design and location of the outfall from desalination plants and to undertake monitoring programmes of physical and chemical changes produced by the discharges. In response to a number of questions, Mr Loizides added that certain lessons had been learned in his country in this respect. The outfall from the first desalination plant in Cyprus had been installed at a distance of 300 meters from the shore, where the sea was about 5 meters in depth. For a more recent plant, which was now operational, the outfall had been located in deeper water at a distance of some 1500 meters from the shore. In the Larnaca desalination plant, the salinity of the sea reached its normal background level at a distance of 50 meters from the outfall. It was also necessary to emphasize that the intake for desalination plants should not be close to the outfall.

*Information on plans for the installation of further desalination capacity in Mediterranean countries*

31. Several experts provided information on the plans in their countries for the development of further capacity for the desalination of seawater and brackish water.

32. Mr Said Abu Jalala (Palestinian Authority) informed the meeting that a desalination master plan had been finalized to provide a new source of freshwater for Gaza and to avoid overuse of the Gaza aquifer. It was planned to desalinate 80,000 m<sup>3</sup> of water a day using the RO method. Studies had been undertaken for the purposes of site selection and lay-out. A cost estimate had been prepared and an environmental impact assessment was being carried out.

33. Mr Ran Amir (Israel) first indicated that the information in the Secretariat's assessment report concerning the desalination of 17,000 m<sup>3</sup> of seawater a day in his country was outdated, as the plant in question had not been in operation for a number of years. However, his Government had now defined plans for the desalination of some 200 million m<sup>3</sup> of water per year. It was planned that this capacity would become operational by 2004-6. A public call for tenders had been made for one plant with a capacity of 100 million m<sup>3</sup> per year. Another major installation and three smaller plants were also planned over the next three or four years. The conclusions and recommendations of the present meeting were therefore of great importance in this context.

34. Mr Jose Luis Sanchez Lizaso (Spain) said that the main problem preventing his country from constructing desalination plants on its Mediterranean coast was the sensitivity of most of the coast, much of which was covered by Posidonia meadows with a width of up to 4 km. He described the research that was being undertaken to assess whether it was feasible to release discharges from desalination plants in Posidonia meadows. A number of aspects were being investigated in this respect, including the tolerance of Posidonia to higher salinity levels and the best way of achieving a high level of dilution in a very small mixing zone. A series of tank experiments were being undertaken and the discharges and effects of plants currently in operation were also being monitored closely. He added that a number of information materials had been produced on this subject and could be made available to the participants.

35. Mr Zoran Jakelic (Croatia) explained that his country possessed significant freshwater resources, particularly in its underground aquifers. However, in view of its very large number of islands, which were attracting significant numbers of tourists, the problem lay more in freshwater distribution. While many islands were connected to inland water sources, there was no stable water supply system for many of the smaller islands. In view of the increased demand for water, particularly for tourism, four desalination plants had recently been constructed and others might be built in future on other islands. However, more studies should be undertaken before proceeding with these plants to develop a better understanding of their impacts. While desalination would never be an important source of freshwater in Croatia, it might be used more widely in future.

36. Mr Louis Vella (Malta) indicated that he would provide a number of written corrections to the figures on desalination contained in the Secretariat's report. It had originally been planned to build six desalination plants in his country, of which four were currently operational. However, as a result of improvements in the distribution of water and the introduction of a pricing policy to control demand, it had now been decided that the other two plants were not required and would not therefore be constructed. There were no further plans to increase desalination capacity in his country.

37. Mr Andrea Cappelli (Amici per la Vita) described a project which had been undertaken, with European Union funding, to develop a geographical information system as a tool to assist the planning of an area undergoing a high level of economic development, with particular emphasis on mining activities, in the city of Khouribga in Morocco. The system was designed to provide the information required for the determination of an integrated sustainable development policy for the protection of the environment and the population and the promotion of economic and social development, including the appropriate management of waste water and mineral resources. The project had been welcomed by the local authorities in Khouribga and similar projects were being requested in other areas of Morocco and in other countries.

## **Agenda item 6. Conclusions and recommendations**

38. The meeting agreed to divide into two working groups, the first on the policy/legal aspects of seawater desalination, with Mr Vella (Malta) in the Chair, and the second on the technical aspects of the subject, with Mr Loizides in the Chair. The two Working Groups took as a basis for their work the "Recommendations for the preparation of guidelines for the management of seawater desalination in the Mediterranean region" (document UNEP(DEC)/MED WG.205/4), prepared by the Secretariat.

39. Reporting on the recommendations of the Working Group on Policy/Legal aspects, Mr Vella indicated that the draft text prepared by the Secretariat had proven to be a satisfactory basis for discussion. The Working Group had made a number of editorial changes to improve the clarity and purpose of the text and had proposed the inclusion of a number of annexes to provide further guidance. These included annexes on the possibility of combining brine with other discharges; energy alternatives and the impact of dual use plants; alternatives and impacts of the various systems of water intake; a model permit for the discharge of brine; a checklist of the essential requirements and considerations for EIAs, taking into account the broader aspects of development; proposed standards for the quality of brine discharges with a view to ensuring a certain uniformity within the region; information on the reporting system under the LBS Protocol; and guidance on the need to set up at the national level an inter-agency task force to determine requirements for desalination plants within the context of a national water demand programme. He added that seawater desalination should be decided upon as part of an integrated water management and conservation programme, within which efforts should be made to make use of other sources of water. He also drew the Meeting's attention to the issue of the discharge of brine from desalination plants under the terms of the LBS Protocol, since brine contained potentially hazardous substances. Another issue to be discussed was the question of the dumping at sea of discharges from the desalination of brackish waters. He pointed out that brines were not included in the list contained in the Dumping Protocol of discharges that could be dumped at sea. Yet many experts were of the opinion that the dumping at sea of brine discharges was less problematic from an environmental point of view than other available options. The question therefore arose as to whether an amendment should be proposed in this respect to the amended Dumping Protocol.

40. In a brief discussion of the possible uses of brine, it was pointed out that the quantities of brine produced from desalination activities enormously exceeded any use that could be envisaged for them, such as the production of salt or other chemicals. It was nevertheless agreed that an annex should be included in the guidelines on possible uses for brine discharges.

41. Turning to the issue of the dumping of brine discharges at sea and the provisions of the Dumping Protocol, the Secretariat pointed out that the amendment of a legal instrument such as a Protocol was a lengthy and complicated process. Moreover, the amended Dumping Protocol had not yet entered into force. Several speakers pointed out that there were sound environmental reasons for the dumping at sea of brine generated from the desalination of brackish water. The dumping of such brine discharges inland ran the risk of polluting ground water. Several speakers concluded that the list contained in the Dumping Protocol was too restrictive and it was agreed that the Secretariat would consult with Governments and legal experts to see how this problem could be addressed.

42. In the discussion of the Working Group's proposed amendments, several speakers proposed amendments which were accepted by the Meeting. It was agreed that desalination should be considered to be an industrial activity, with the consequence that its discharges would come within the framework of the LBS Protocol. Greater emphasis was also placed on the need for a baseline survey before the commencement of desalination activities, for the use of modeling to predict impacts and for continuous monitoring during operation. It was

also agreed that the guidelines should cover the construction of desalination plants and any transboundary effects. Emphasis should also be placed on the use of renewable sources of energy, particularly in the case of small-scale plants.

43. Presenting the recommendations made by the Working Group on technical aspects, Mr Loizides indicated that, among the drafting amendments proposed during the discussion, an attempt had been made to clarify the text by including separate parts covering the potential impacts of seawater desalination and a list of coherent mitigation measures and recommendations. An important subject that had been missing from the proposed recommendations concerned the location and site selection for new desalination plants. An additional section should therefore be placed at the beginning of the guidelines listing criteria and setting out site selection recommendations. He added that the Working Group had come to the conclusion that, although the practice occurred elsewhere in the world, it was not appropriate for psychological and practical reasons in the Mediterranean region to discharge brine diluted with sewage effluent. It was not logical to locate a desalination plant close to a sewage treatment plant, not least due to the difficulty in obtaining good quality input water. Moreover, he said that treated effluent sewage was recyclable and, in accordance with the SAP, its disposal at sea should not therefore be encouraged. The discussion had also focused on the need for pre- and post-construction monitoring and the proposed text had been redrafted to take into account the relevant Mediterranean experience and the information provided by the experts. Following a brief discussion, the Meeting adopted these recommendations.

44. The Meeting's recommendations, as amended in the light of the discussions, are reproduced in this report as Annex III.

#### **Agenda item 7. Other business**

45. In response to a request for clarification, the Secretariat indicated that brine discharges would not need to be included in calculations of the national baseline budgets required under the SAP in terms of their salinity, since salt was not covered by the SAP. However, the trace metal content of brine should indeed be included in the calculation of the baseline budget. Countries should therefore calculate, for example, the volume of copper emitted in brine discharges.

#### **Agenda item 8. Closure of the Meeting**

46. After hearing a closing address from *Assessore* Mirco Bresciani, and following the usual exchange of courtesies, the Meeting rose at 6 p.m.

**ANNEX I  
ANNEXE I**

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## **ANNEX II**

### **AGENDA**

1. Opening of the Meeting
2. Election of Officers
3. Adoption of the Agenda and Organization of Work
4. Scope and Purpose of the Meeting
5. Discussion and recommendations for the management of desalination plants in the Mediterranean
  - 5.1 Review of desalination activities and environmental impacts in the Mediterranean and other regions
  - 5.2 Review and analysis of the draft assessment of environmental impacts of desalination plants in the Mediterranean
  - 5.3 Review and analysis of draft Recommendations for the management of desalination plants and of brine discharges
6. Conclusions and recommendations
7. Other Business
8. Closure of the Meeting

## ANNEX III

### Conclusions and recommendations of the Experts meeting on environmentally sound management of sea water desalination plants and brine discharges

#### 1. Policy/Legal recommendations

- The Mediterranean countries are experiencing increasing demand for water. Sea water desalination can provide much needed relief.
- Water desalination activities could induce potential socio-economic growth which could in turn affect the national land use planning and development plans.

#### **Regional and national marine environment protection policy**

- Desalination activities are considered as an industrial activity.
- Sea water desalination can have potential adverse impacts on the marine environment if not well designed and managed.
- Desalination activities should be an integrated part of national water management and protection plans.
- Sea water desalination activities should conform to the provisions of the LBS protocol and biodiversity.
- EIA study is an essential prerequisite on deciding on the appropriate site and technology to minimize impacts. EIA process should consider, among others, the following:
  - energy use
  - seawater intake and brine discharge outlet
  - use of hazardous chemicals
  - combining brine with other discharges
  - quality of intake water of all discharges and emissions
  - potential growth of water demand
  - socio-economic impacts including excessive development in inappropriate areas.
  - monitoring programme and management plan
  - hydraulic study
  - siting
  - sea water masses circulation
  - environment risk assessment
  - Transboundary effects

#### **National water management policy**

- Desalination activities development should be considered as an integral part of national water resources management policy.

- There should be established an interagency task force including the national environmental authority as an essential element in the formulation of this policy.
- The interagency task force should include all relevant national bodies dealing with water management including NGOs, water consumers and users.
- The environmental authority should be responsible for permitting the discharge of the brine .

## **2. Technical recommendations**

- To prepare the guidelines according to the updated form of the document UNEP(DEC)/MED WG.205/4.
- To include the elaborated monitoring programme as an integrated part of the guidelines.
- To include the following annexes in the guidelines:
  - dispersion models
  - check list for EIA study
  - energy use alternatives especially alternatives sources for small scale plants
  - combining brine with other discharges
  - water intake alternatives with special emphasis to reduce the pre-treatment use of chemicals
  - model for a permit for construction of sea water desalination plants and operational conditions
  - possible reuse of brine
  - classification of technologies in relation to their impacts
  - example of brine quality standards
  - reporting model taking into consideration the provisions of LBS protocol
  - Developing a model for duties of the Interagency task force for desalination activities

## **3. Points raised for further clarification from the secretariat**

- Classification of the brine according to the annex I of the LBS protocol taking into account the brine itself and potential hazardous constituents.
- Finding the best available techniques for the disposal of brine from small inland desalination facilities.