Non-conventional water resources uses study in the Mediterranean

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ACRONYMS AND ABBREVIATIONS

Table 1 provides a list of the acronyms used

Table 1 Acronyms used

Acronym /abbreviation	Meaning	Comment
ADA	American Desalting Association. See AMTA	
AEDyR	Asociación Española de Desalación y Reutilización	
AMTA	American Membrane Technology Association	
ASCE	American Society of Civil Engineers	
AWWA	American Water Works Association	
BOD_5	5-day Biochemical Oxygen Demand[1]	
BOE	Boletín Oficial del Estado/Spanish Official Journal	
COD	Chemical Oxygen Demand	
ED	Electrodialysis	Desalting technology
EDI	Electrodionization	Desalting technology
EDS	European Desalination Society	
EPA	Environmental Protection Agency	
EU	European Union	
EUWI	European Union Water initiative	
IAEA	International Atomic Energy Agency	
IDA	International Desalination Association	
ISO	International Organization for Standardization	http://www.iso.org/
ISSN	International Standard Serial Number	http://www.issn.org/
MAP	Mediterranean Action Plan	
MED	Multiple Effect Distillation	Desalting technology
MED-MVC	Mechanical Vapour Compression	Desalting technology
MED-TVC	MED with Thermal Vapour Compression	Desalting technology
MENA	Middle East and North Africa	
MPC	Mediterranean Partner Country	
MSF	Multi-stage Flash	Desalting technology
NCWR	Non-conventional Water Resources	
NF	Nanofiltration	Desalting technology
NFP	National Focal Point	
NUTS	Nomenclature of territorial units for statistics	
NWSIA	National Water Supply Improvement Association	
OSW	Office of Saline Water	
OWRT	Office of Water Research and Technology	
RO	Reverse Osmosis	Desalting technology
SMAP	Short and Medium-term Priority Environmental Action Programme	
TDS	Total Dissolved Solids	
TSS	Total Suspended Solids	
UAE	United Arab Emirates	
UNEP	United Nations Environment Programme	
UN-ESCWA	United Nations Economic and Social Commission for Western Asia	
WFD	Water Framework Directive. Is the 2000/60/EC	
WHO	World Health Organization	
WMO	World Meteorological Organization	
WTTP	Water Treatment Technology Program	

[1] 1 p.e. (population equivalent) means the organic biodegradable load having a five-day biochemical oxygen demand (BOD5) of 60 g of oxygen per day **(**Council Directive 91/271/EEC)

1 EXECUTIVE SUMMARY

This thematic study focus on the use of non –conventional water resources in Mediterranean countries (a theme of the Turin Action Plan on local water management, October 1999). It is one of the four topics selected by EMWIS Steering Committee in 2004 to carry out a synthesis on the basis of experiences. The report covers the three topics considered in the terms of reference issued by EMWIS Technical Unit: desalination, wastewater reuse and precipitation enhancement.

The study was based on a desk research and a survey among EMWIS National Focal Points. There were sixteen countries included in the survey: the twelve Mediterranean Partners Countries (even though Cyprus and Malta are already EU members) and the EU countries with a Mediterranean shore: France, Greece, Italy and Spain.

This document offers a general overview on the situation in each topic: projects, programmes, plants, and other aspects: organizations, research, training and documentation (databases, journals, newsletters, reports, books, and proceedings, either in paper or electronic format).

2 INTRODUCTION

2.1 Background

The following text comes from the terms of reference of this study. It defines the notion of *Non-conventional water sources.*

The Non-conventional water sources refer primarily to water reclamation, in various degrees of quality, from urban wastewater, brackish groundwater, and seawater. Rain stimulation is also included in this category. In this way, better quality water can be made available for uses with more demanding quality requirements. The ecological impact on aquatic ecosystems of a substantial decrease in the discharge of wastewater into rivers, lakes and coastal zones must be analysed to ensure the establishment of a policy sensitive to environmental protection, safeguarding water from pollution.

The reuse of treated municipal wastewater in agriculture is consolidated practice in many Mediterranean countries. However, there is a need to establish monitoring and control systems to ensure reuse of suitably treated water since in many countries there have been numerous indications of major health hazards due to reusing raw sewage. The reuse of treated wastewater is of major interest in the Mediterranean basin.

Desalination of seawater or brackish water for industrial use or drinking water supply entails problems of an economic and energy character, whereas technology is readily available and usable. The major constraint in using this resource is the cost of the product and supply services. Desalination therefore appears more feasible and economically competitive in insular or coastal areas with serious water shortages and preferably, where low cost energy is available. However, it has become certain that in the medium to long-term non-conventional water resources will gain increasing importance to the supply side of the balance sheet to avoid deficits in fresh water budgets. Drawing on existing *experience and up-to-date research in this sector, exchange/transfer of technology and capacity building are important elements in order to accommodate future water management planning and investment decisions by national administrations and water authorities.*

2.2 Objectives of the study

The objective of this thematic study is to provide a synthesis analysis on the use of non-conventional water resources in Euro-Med countries, with:

- a state of the art on non-conventional water resources, including a strength and weakness analysis for each type of resource and potential application domains for the Med Partner Countries (MPC)
- For each type of non-conventional water resources: bibliography and list of resource centers (e.g. research centers, universities, etc.)
- An inventory of projects (existing or planned)
- A review of current policy on the use of non-conventional water resources

It is targeting universities, research groups, industries, and water authorities of the Euro-Med countries.

2.3 Thematic scope of the survey

The study on non-conventional water resources in the Mediterranean was based on three topics:

1) Desalination

2) Wastewater reuse

3) Precipitation enhancement

2.4 Geographic scope of the survey

From a geographical point of view, 16 countries participated in the study:

a) Six countries of the European Union: Cyprus, France, Greece, Italy, Malta and Spain,

b) Ten Mediterranean Partners of the EU: Algeria, Egypt, Israel, Jordan, Lebanon, Morocco, Syrian Arab Republic, Tunisia, Turkey and Palestine[2].

For each country, Table 2 provides its alphabetical code with three letters, its numerical code and its name in English and French.

Table 2 Mediterranean countries and territories ISO 3166-1 alpha-3 code

Code	Numerical code	Country or area name (EN)	Pays ou région (FR)
CYP	196	Cyprus	Chypre

[2] The name Palestine is used according with the United Nations document A/RES/52/250, dated 1998-07-07 titled Participation of Palestine in the work of the United Nations. From a geographical point of view the term, according with UN Statistics Division (Composition of macro geographical (continental) regions, geographical sub-regions, and selected economic and other groupings) should be Occupied Palestinian Territory. (URL: http://unstats.un.org/unsd/methods/m49/m49regin.htm#asia)

Code	Numerical code	Country or area name (EN)	Pays ou région (FR)
DZA	012	Algeria	Algérie
EGY	818	Egypt	Égypte
ESP	724	Spain	Espagne
FRA	250	France	France
GRC	300	Greece	Grèce
ISR	376	Israel	Israël
ITA	380	Italy	Italie
JOR	400	Jordan	Jordanie
LBN	422	Lebanon	Liban
MAR	504	Morocco	Maroc
MLT	470	Malta	Malte
PSE	275	Occupied Palestinian Territory	Territoire palestinien occupé
SYR	760	Syrian Arab Republic	République arabe syrienne
TUN	788	Tunisia	Tunisie
TUR	792	Turkey	Turquie

Source: United Nations Statistics Division. *Countries or areas, codes and abbreviations*. URL: http://unstats.un.org/unsd/methods/m49/m49alpha.htm

Table 3 complements the above, indicating the Sea (Mediterranean, Black or Red Sea) or Ocean (Atlantic) they border. This information is relevant to the first topic of the study: desalination.

Table 3 EMWIS countries and their coastlines

Code	Mediterranean Sea	Black Sea	Red Sea	Atlantic Ocean
CYP	YES	NO	NO	NO
DZA	YES	NO	NO	NO
EGY	YES	NO	YES	NO
ESP	YES	NO	NO	YES
FRA	YES	NO	NO	YES
GRC	YES	NO	NO	NO
ISR	YES	NO	YES	NO
ITA	YES	NO	NO	NO
JOR	NO	NO	YES	NO
LBN	YES	NO	NO	NO
MAR	YES	NO	NO	YES
MLT	YES	NO	NO	NO
PSE	YES	NO	NO	NO
SYR	YES	NO	NO	NO
TUN	YES	NO	NO	NO
TUR	YES	YES	NO	NO

3 MATERIAL AND METHODS

The study was carried out in two phases. The first one goes through a comprehensive analysis of the available documentation. The second one, in close connection with the former one, filling in a questionnaire to obtain, not only field data but to improve, to update and even to modify the existing information:

Phase 1: Search, analysis and evaluation of the available documentation.

Phase 2: Preparation of a draft questionnaire, sending of this draft to the National Focal Points for analysis and comments, drafting the final questionnaire, sending it to all the National Focal Points, answers to questions, analysis of the answers and drafting of the final report.

The questionnaire (see Annex 1) used a two-fold approach:

- An *inventory* of desalination and precipitation enhancement and of the results of wastewater reuse.
- A review of the legal framework for reuse in each country.

4 RESULTS

4.1 Introduction

The results gained are also organised in two parts: the first one describes, under the generic title of *Resources,* EMWIS topics (Organisations, Research, Training and Documentation) related to the three issues of the study: desalination, wastewater reuse and precipitation enhancement and a second one which presents the study results for each country.

4.2 Overview

Table 5 provides a general overview of the aspects on which information is provided.

Table 4 General overview

Topic	Desalination	Wastewater reuse	Precipitation enhancement
Plants, programmes, projects	YES	YES	YES
Organisations	YES	YES	YES
Research centres	YES	YES	NO
Research projects	YES	YES	YES
Training centres	YES	NO	NO
Training programmes	-	NO	NO
Documentation	YES	YES	YES

At this point it is important to refer to three organizations, which, financed by the European Union and not assigned to any country in particular, have information as thematic objective and the Mediterranean as geographic space.

Owing to their scope in the Mediterranean context, the three following organisations, financed by the European Union, aim at conveying the information directly or indirectly related to water:

1) The Euro-Mediterranean Information System on know-how in the Water sector (EMWIS)/Système Euro-Méditerranéen d'Information sur les savoir-faire dans le Domaine de l'Eau (SEMIDE), has, in its

website, a section dedicated to desalination (URL: http://www.semide.net/topics/Desalination) and another one to wastewater reuse (URL: http://www.semide.net/topics/WaterReuse). The latter includes information on the activities of the Joint Mediterranean EU Water Initiative/Water Framework Directive Process.

2) SMAP Clearing House. It is defined as "*An Internet Portal to navigate the Mediterranean "Sea" of Information on the Environment*"**.** URL: http://smap.ew.eea.europa.eu/.. URL: http://ec.europa.eu/environment/smap/home.htm

3) The ***EuroMed Info Centre*** is an EU-funded Regional Information and Communication project on the European and Mediterranean partnership. It was initiated by the European Commission and is financed by the MEDA Regional Information and Communication programme. Its main aim is to make the MEDA Regional Programme and the EU's partnership with the Mediterranean more visible. URL: http://www.euromedinfo.eu/

Table 5 presents the available information on non-conventional water resources. Shortage of data shall be mentioned.

Table 5 Non conventional water resources in a few countries (hm^3). (Last year available)

Water resource	Country	Year	Volume
Desalinated water	CYP	2004	29
	ISR	2001	12
	MAR	2003	3
	MLT	2004	18
Reused water	CYP	2003	4
	ISR	2001	266
- Agriculture, forestry, fishing	CYP	2003	6
- of which irrigation	CYP	2004	6

Source: EUROPEAN COMMISSION. EUROSTAT (2006, p. 29)[3]

4.2.1 Desalination

The information source was the *19th IDA Worldwide Desalting Plant Inventory***,** dated 2005-12-31.

Before dealing with tables, it is necessary to include two answers to the Frequently Asked Questions about completeness and accuracy of the IDA Inventory.

[3] EUROPEAN COMMISSION. EUROSTAT [PINTUS, F. (Edition Manager)]. 2006. *Environmental statistics in the Mediterranean Countries. Compendium 2005.* Luxembourg: Office for Official Publications of the European Communities, 2006. 111 p. URL: http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-74-06-823/EN/KS-74-06-823-EN.PDF (English) and EUROPEAN COMMISSION. EUROSTAT [PINTUS, F. (Responsable de l'édition)]. 2006. *Statistiques environnementales dans les pays méditerranéens. Compendium 2005*. Luxembourg: Office des publications officielles des Communautés européennes, 2006. 111 p. URL: http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-74-06-823/FR/KS-74-06-823-FR.PDF (French)

"2) Is it complete?

We aim to give complete coverage of all desalination plants contracted anywhere in the world with a capacity of more than 100 m^3/d[4]. The reality is that we can only include plants were suppliers have submitted details to us. We estimate that our coverage is in fact as follows:

- *100% coverage of plants with a capacity of more than 10 000 m^3/d,*
- *80% coverage of plants with a capacity of between 1 000 m^3/d and 9 999 m^3/d.*
- *50% coverage of plants with a capacity of between 100 m^3/d and 999 m^3/d.*

As plants with a capacity of between 1 000 m^3/d and 9 999 m^3/d represent 15% of total contracted capacity, and those with a capacity of between 100 m^3/d and 999 m^3/d represent 2% of total capacity, we estimate our coverage of the market to be around 96% of total capacity. In future we will be working to increase our coverage [sic] of smaller plants with the long term aim of achieving 99% total coverage.

3) Is the inventory accurate?

The Inventory has very high standards of accuracy, but it is not infallible (and we cannot accept responsibility or liability for any loss or damage suffered as a result of any inaccuracies which may be within the database). GWI DesalData thoroughly audited the information from the 18th Inventory[5] before it was included in the 19th Inventory. In doing so it eliminated around 3,2 million cubic metres of suspect capacity, which had arisen either as a result of suppliers submitting duplicate references for the same plant under different names, or as a result of plants being announced, but never actually built. We estimate that this has reduced the error rate to less than 3%. Our long term goal is to reduce the error rate to 1%. Most of the errors are the result of the fallibility of the desalination companies which supply information on the projects they have been involved in."

In addition, we must notice a significant problem with the IDA inventory, i.e., the undefined location of the facility, with one obvious consequence, which is the difficulty of guaranteeing that similar facilities do not exist elsewhere.

In the mentioned inventory, four fields deals with this aspect: *CountryName*, *Location*, *ProjectName* and *Customer*. Then, referring to the first three, we can see in Table 7 that, out of the 2,034[6] plants in the target zone of the study, 332, with an installed capacity of 381,415 m^3/day, have coincidences with the *CountryName*, *Location* and *ProjectName*, 344 plants, with an installed capacity of 393,569 m^3/day with the CountryName and *Location* and 1,874, with an installed capacity of 6,743,270 m^3/day, have coincidences with the *Location* and *ProjectName.*

Table 6 Coincidences CountryName-Location-ProjectName

Coincidence	#	m^3/day

[4] NOTE: The 18th Inventory provided detailed information on the plants with a capacity equal or superior to 700 m^3/day.

[5] WANGNICK, in his Report, explains the method used for obtaining the information: "The essential data have been disclosed to the author by the desalting plant suppliers. Apart from this, the Report relies on information gained from plant operators, membrane suppliers, national and international organisations, suppliers of chemical additives, specialist literature, newspapers and journals, and business friends."

[6] In the number 2,034, it was also necessary to delete four plants that, while being assigned to France, are not in metropolitan France, i.e.: Bora-Bora (1), New Caledonia (2), Mayotte (1). 14 plants have also been deleted (Boujdour [4], El Aaiun [4], Laayoune [3][6], Phos Boucraa [1] and Smara[1]) that, while being assigned to Morocco, are in Western Sahara[.

Coincidence	#	m^3/day
CountryName = Location = ProjectName	332	381 415
CountryName = Location	344	393 569
Location = ProjectName	1.874	6 743 270

Some other problems, further to what could be considered as typing errors, are geographical inconsistencies (West Desert and Western Desert), errors in some Locations (there seem to be two non-existent in Spain Cerveza in Spanish, Beer in English and bière in French) and uncertainties: Military Zon [sic], Mobile unit, Off Shore, or Oil camp.

The *Customer* problem concerns the degree of uncertainty in its designation. Not only 846 plants have the word UNKNOWN appearing in the *Customer* field, but in other 117 plants a generic word appears (see Table 8), not including those that have a more or less known acronym.

Table 7 Facilities with an indefinite customer

Number of times	Customer
846	Unknown
48	Municipality
17	Government
14	Hotels
8	City
8	Hotel
4	Ministry
4	Power station
3	Electricity
3	Oil refinery
3	Private
3	Sardinia Author
1	Oil refineries
1	On board ship

In spite of errors and uncertainties regarding the accuracy and completeness of the Inventory ..., the Tables: *Table 8 Mediterranean and* world, *Table 9 Mediterranean and world. Number and capacity of desalting plants according to raw water type*, *Table 10 Mediterranean and* world. Number and capacity of desalting plants according to desalting technology[7], *Table 11 Mediterranean and world. Number and capacity* of desalting plants according to daily output and *Table 12 Mediterranean and world. Number and capacity of desalting plants according to user category* summarise the situation in the Mediterranean and in the world, with some indications on the number of facilities (Column #) and their total capacity (in cubic metres per day). In the five Tables, the classification by rows has been done according to the decreasing values of the column that express the existing total capacity in the Mediterranean.

[7] The technologies and their Mediterranean context can be consulted, for example: UNEP/MAP. 2003. *Sea water desalination in the Mediterranean: assessment and guidelines*. 133 p. MAP Technical Reports Series No. 139. URL: http://195.97.36.231/acrobatfiles/MTSAcrobatfiles/mts139eng.pdf and UN-ESCWA. 2001. *Water Desalination Technologies in the ESCWA Member Countries*. 177 p. URL: http://www.escwa.org.lb/information/publications/edit/upload/tech-01-3-e.pdf

Table 8 Mediterranean and world. Number and capacity of desalting plants according to plant status

Status	Mediterranean		World	
	#	m³/day	#	m³/day
Online	1 002	4 550 067	4 917	26 826 720
Online (Presumed)	623	1 135 739	3 548	10 959 381
Construction	25	1 127 868	89	2 698 751
Offline (Presumed)	365	592 951	3 681	5 733 296
Offline (Mothballed)	11	94 000	14	111 036
Offline (Decommissioned)	7	24 512	59	541 278
Offline	1	500	1	500
TOTAL	2 034	7 525 637	12 309	46 870 962

Source: GWI DesalData (2006)

Table 10 provides the criteria for classifying the supplied water type in two consecutive inventories (18th and 19th) of the International Desalination Association. The changes in the limits for brackish water and sea water, as well as the fact that in the 19th Inventory these limits overlapped, made the comparison between both Inventories difficult to achieve.

Table 10: Classification of the supplied water in the two IDA inventories. TDS in mg/L.

Water type	19th (2006)	18th (2004)
Pure water	Less than 500	=
River water	500 to 3 000	=
Brackish water	1 500 to 5 000	3 000 to 20 000
Seawater	15 000 to 50 000	20 000 to 50 000
Brine	Not mentioned at Intro	More than 50 000
Waste water	Not indicated at Intro	Not mentioned
Unknown	Not applicable	Not applicable

Table 9 Mediterranean and world. Number and capacity of desalting plants according to raw water type

Raw water	Mediterranean		World	
	#	m³/day	#	m³/day
Seawater	848	4 893 008	3 162	27 366 139
Brackish water	891	1 783 459	5 331	10 105 260
River water	70	378 609	1 037	3 644 527
Waste water	54	178 790	741	2 342 079
Pure water	44	64 835	1 266	2 001 095
Brine	14	17 638	61	98 194
Unknown	113	209 298	711	1 313 668
TOTAL	2 034	7 525 637	12 309	46 870 962

Source: GWI DesalData (2006)

Table 10 Mediterranean and world. Number and capacity of desalting plants according to desalting technology

Technology	Mediterranean	World

	#	m^3/day	#	m^3/day
RO	1 447	6 011 425	8 733	23 078 404
MSF	117	569 632	794	16 111 984
ED	204	406 841	1 109	1 866 256
MED	85	159 736	654	1 374 802
MED-MVC	104	118 263	380	551 663
MED-TVC	34	112 603	186	1 302 961
NF	9	57 510	101	1 825 736
EDI	9	8 641	129	193 076
Hybrid	0	0	1	6 300
Freeze	0	0	1	210
Unknown	25	80 986	221	559 570
TOTAL	2 034	7 525 637	12 309	46 870 962

Source: GWI DesalData (2006)

Table 11 Mediterranean and world. Number and capacity of desalting plants according to daily output

Daily output (m^3/day)	Mediterranean		World	
	#	m^3/day	#	m^3/day
50 000 and more	26	3 065 358	149	21 170 674
1 000 to 9 999	720	2 055 955	3 761	10 933 200
10 000 to 49 999	104	1 946 372	596	11 992 007
100 to 999	1 182	457 952	7 743	2 775 081
Unknown	2	Unknown	60	Unknown
TOTAL	2 034	7 525 637	12 309	46 870 962

Source: GWI DesalData (2006)

Table 12 Mediterranean and world. Number and capacity of desalting plants according to user category[8]

User category	Mediterranean		World	
	#	m^3/day	#	m^3/day
Municipal	710	5 440 911	3 702	31 778 752
Industrial (captive)	646	1 134 914	5 868	10 321 122
Irrigation	157	459 744	284	963 711
Power	157	212 164	1 129	2 178 737
Tourism	277	203 757	705	486 767
Military	50	38 861	420	560 154
Discharge	11	5 207	82	420 561
Demonstration	6	4 739	75	68 413
Unknown	20	25 340	44	92 745
TOTAL	2 034	7 525 637	12 309	46 870 962

Source: GWI DesalData (2006)

According to WANGNICK (2004, p. 2-2), the Total Dissolved Solids (TDS) in milligrams per litre (mg/L) in relation with the category of users are those given in table 13.

[8] Categories of users can be defined according to some international standards, such as the International Standard Industrial Classification of all economic activities (ISIC) Rev. 3.1, as adopted by the Statistical Commission of the United Nations in 2002. URL: http://unstats.un.org/unsd/cr/registry/regcst.asp?Cl=17 , which would facilitate the classification process and their incorporation into other statistics..

Table 13 TDS according to the category of users

User category	TDS lower limit	TDS upper limit
Industrial (captive)	-	< 10
Irrigation	-	< 1 000
Military	10	< 1 000
Municipal	10	< 1 000
Power	-	< 10
Tourism	10	< 1 000
Discharge	NO DATA	NO DATA
Demonstration	NO DATA	NO DATA
Unknown		

Source: WANGNICK (2004, p. 2-2)

In any case, the European Union's approach to the quality of waters intended for human consumption (Directive 98/83/CE of the Council, of 3 November 1988, DOC L 330 of 1998-12-05) does not include the total dissolved solids in the 48 parameters involved. The most related parameter is the (specific) conductivity expressed in microsiemens per centimetre (20 µS cm^{-1} per ºC), to which an indicative value (Part C of Annex I) of 2 500[9] is given. On the other hand, the values of the chemical parameters (Part B of the above-mentioned Annex I) can raise problems of fulfilment in the case of desalination using semi-permeable membranes[10].

The *Guidelines for Drinking-water Quality. Incorporating first addendum to third edition. Volume 1 - Recommendations*. (WHO, 3rd ed., 2006) URL: http://www.who.int/water_sanitation_health/dwq/gdwq3rev/en/, say, as regards the TDS, "Reliable data on possible health effects associated with the ingestion of TDS in drinking-water are not available, and no health-based guideline value is proposed." (p. 444).

What is considered here is the modification of the organoleptic characteristics of water according to the TDS concentration: "The palatability of water with a TDS level of less than 600 mg/litre is generally considered to be good; drinking-water becomes significantly and increasingly unpalatable at TDS levels greater than about 1000 mg/litre." (p. 218)

In volume 2 (*Health criteria and other supporting information*) of the previous issue (2ª, 1996) of the Guidelines… the TDS limits were indicated according to the panels of tasters, as follows: excellent, less than 300 mg/litre; good, between 300 and 600 mg/litre; fair, between 600 and 900 mg/litre; poor, between 900 and 1200 mg/litre; and unacceptable, greater than 1 200 mg/litre

Reading Tables 11 and 13 suggests that the quality of the desalinated water and the technology used to obtain it should be taken into account. In the Mediterranean, the dominant technology is Reverse Osmosis (6 011 425 m^3/day vs a total of 7 525 637 m^3/day) This process is carried out without any change of phase, so that the desalinated water has a total amount of dissolved solids and ionic concentrations that can be controlled for drinking water supply. Table 15 indicates, for information purpose, the legal provisions or recommendations of the European Union, of the Environmental Protection Agency (United States) and of the World Health Organisation. All of them are available on line; the 98/83/CE Directive is found in EUR-Lex (URL: http://eur-lex.europa.eu/)

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[9] To obtain approximately the TDS in grams per litre from the electrical conductivity in microsiemens per litre at 20 ºC, a coefficient of 0.714 is used.

Table 14 Drinking water quality regulations/recommendations

Source	Title	Reference
EU	Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption	OJ L 330, 1998-12-05, p. 32–54 (Reference 31998L0083)
EU	Directive 98/83/CE du Conseil du 3 novembre 1998 relative à la qualité des eaux destinées à la consommation humaine	OJ L 330, 1998-12-05, p. 32–54 (Reference 31998L0083)
US EPA	National Primary Drinking Water Regulations	US Code of Federal Regulations (CFR) Title 40-Protection of Environment Chapter I-Environmental Protection Agency Part 141-National **Primary** Drinking Water Regulations http://www.access.gpo.gov/nara/cfr/waisidx_02/40cfr141_02.html
US EPA	National Secondary Drinking Water Regulations	US Code of Federal Regulations (CFR) Title 40-Protection of Environment Chapter I-Environmental Protection Agency Part 143-National **Secondary** Drinking Water Regulations http://www.access.gpo.gov/nara/cfr/waisidx_02/40cfr143_02.html
WHO	WHO Guidelines for drinking-water quality, 3rd ed. (2004)	http://www.who.int/entity/water_sanitation_health/dwq/gdwq3rev/en/index.html

For each country, Tables 17, 18, 19, 21 and 22 correspond to the breakdown per country of columns entitled “Mediterranean” in Tables 9, 11, 12, 13 and 14. In the five Tables, the classification by rows has been done according to the decreasing values of the column that expresses the existing total capacity in each country. The columns were arranged by decreasing order of the sum of the total capacity referring to the possible values of each variable. For example, in Table 15, the column order is 2-3-1-5-7-6-4. The **Unknown** column, when it exists, precedes the TOTAL column.

A last comment: given the significance of desalination in the Canary Islands, which are not in the Mediterranean Sea, Tables 17, 18, 19, 21 and 22 provide data corresponding to Spain, which has been divided in two: the data corresponding to peninsular Spain, the Balearic islands and the independent cities of Ceuta and Melilla (line *ESP*) and those corresponding to the Canary Islands [line *ESP (IC)]*.

Table 15 Plant status code

Code	Status
1	Construction
2	Online
3	Online (Presumed)
4	Offline
5	Offline (Presumed)
6	Offline (Decommissioned)
7	Offline (Mothballed)

Table 16 Mediterranean countries. Number and capacity of desalting plants according to plant status

Plan status code	**2**		**3**		**1**		**5**		**7**		**6**		**4**		**TOTAL**	
ISO code	**#**	**m^3/day**	**#**	**m^3/day**	**#**	**m^3/day**	**#**	**m^3/day**	**#**	**m^3/day**	**#**	**m^3/day**	**#**	**m^3/day**	**#**	**m^3/day**
ESP	266	1 882 114	97	203 753	13	150 410	39	29 820							415	2 266 097
DZA	39	570 704	35	114 992	5	888 888	66	151 758							145	1 726 342
ITA	127	240 344	115	303 358			79	208 125							321	751 827
ESP (IC)	110	439 156	137	158 111	2	1 200	27	17 961	11	94 000	1	20 000			288	730 428
ISR	21	429 980	12	54 762	1	83 270	13	27 526							47	595 538
EGY	248	307 114	114	93 674	4	4 100	43	38 254							409	443 142
JOR	26	229 016	2	1 692			8	8 445							36	239 153
FRA	32	202 712	22	20 152			17	13 782							71	236 646
MLT	8	2 473	14	97 378			13	54 068							35	153 919
CYP	8	107 125	3	2 640			6	1 548			6	4 512	1	500	24	116 325
TUN	14	35 387	25	39 422			17	14 060							56	88 869
GRC	59	39 599	20	20 793			12	20 085							91	80 477
LBN	10	19 323	7	9 056			4	1 231							21	29 610
TUR	17	23 591	7	2 068			6	1 374							30	27 033
SYR	7	7 393	6	6 088			5	2 095							18	15 576
MAR	3	4 500	6	6 360			10	2 819							19	13 679
PSE	7	9 536	1	1 440											8	10 976
TOTAL	**1 002**	**4 550 067**	**623**	**1 135 739**	**25**	**1 127 868**	**365**	**592 951**	**11**	**94 000**	**7**	**24 512**	**1**	**500**	**2 034**	**7 525 637**

Source: GWI DesalData (2006)

Table 17 Mediterranean countries. Number and capacity of desalting plants according to raw water type

Raw water	**Seawater**		**Brackish water**		**River water**		**Waste water**		**Pure water**		**Brine**		**Unknown**		**TOTAL**	
ISO code	**#**	**m^3/day**	**#**	**m^3/day**	**#**	**m^3/day**	**#**	**m^3/day**	**#**	**m^3/day**	**#**	**m^3/day**	**#**	**m^3/day**	**#**	**m^3/day**
ESP	109	1 282 145	222	741 309	28	64 704	27	98 136	10	8 317	5	13 860	14	57 626	415	2 266 097
DZA	70	1 488 771	65	156 651	3	67 100							7	13 820	145	1 726 342
ITA	91	435 727	179	183 380	9	51 192	13	34 711	19	29 087			10	17 730	321	751 827
ESP (IC)	183	587 034	92	94 504			8	44 200					5	4 690	288	730 428
ISR	10	455 309	26	90 547	5	24 480			1	144	2	400	3	24 658	47	595 538
EGY	239	280 983	108	90 951	2	394	2	1 100	1	5 000	6	2 600	51	62 114	409	443 142
JOR	4	5 473	27	230 232	2	1 800					1	778	2	870	36	239 153
FRA	13	11 244	25	28 974	15	165 907	3	340	10	18 737			5	11 444	71	236 646
MLT	20	145 599	14	8 170									1	150	35	153 919
CYP	18	112 508	6	3 817											24	116 325
TUN	17	8 042	38	80 555									1	272	56	88 869
GRC	52	45 095	33	29 848	1	1 500			3	3 550			2	484	91	80 477
LBN	6	15 372	7	3 018									8	11 220	21	29 610
TUR	7	12 706	19	13 412	3	612	1	303							30	27 033
SYR			16	15 176	1	120							1	280	18	15 576
MAR	6	2 010	12	10 669									1	1 000	19	13 679
PSE	3	4 990	2	2 246	1	800							2	2 940	8	10 976
TOTAL	**848**	**4 893 008**	**891**	**1 783 459**	**70**	**378 609**	**54**	**178 790**	**44**	**64 835**	**14**	**17 638**	**113**	**209 298**	**2 034**	**7 525 637**

Source: GWI DesalData (2006)

Table 18 Mediterranean countries. Number and capacity of desalting plants according to desalting technology

Technology	RO		MSF		ED		MED		MED-MVC		MED-TVC		NF		EDI		Unknown		TOTAL	
ISO code	**#**	**m^3/day**	**#**	**m^3/day**	**#**	**m^3/day**	**#**	**m^3/day**	**#**	**m^3/day**	**#**	**m^3/day**	**#**	**m^3/day**	**#**	**m^3/day**	**#**	**m^3/day**	**#**	**m^3/day**
ESP	342	2 084 289	4	7 943	38	97 617	10	7 396	8	7 686	1	1 000	8	54 510			4	5 656	415	2 266 097
DZA	75	1 491 111	22	168 231	24	22 016	12	25 149	6	6 302	6	13 533							145	1 726 342
ITA	188	289 832	37	241 550	52	99 201	15	32 786	19	42 430	3	24 630			3	1 578	4	19 820	321	751 827
ESP_70	212	478 776	10	56 560	12	78 893	3	37 496	48	39 913	2	38 600					1	190	288	730 428
ISR	28	509 313	2	7 191	10	33 917	2	21 028	3	850					1	239	1	23 000	47	595 538
EGY	316	314 121	16	38 932	38	41 760	11	6 297	11	10 332	11	11 400					6	20 300	409	443 142
JOR	33	236 516			2	1 537					1	1 100							36	239 153
FRA	49	206 045	1	144	1	356	11	13 444	2	220	1	100	1	3 000	3	6 007	2	7 330	71	236 646
MLT	26	120 908	5	28 261	1	550	1	1 400			2	2 800							35	153 919
CYP	11	107 642	9	6 263			1	110	2	510	1	1 800							24	116 325
TUN	21	67 385	2	457	19	12 290	9	4 340			2	1 080			2	817	1	2 500	56	88 869
GRC	69	38 273	6	12 180	3	16 100	2	1 714	5	10 020							6	2 190	91	80 477
LBN	16	14 420	1	520			2	3 460			2	11 210							21	29 610
TUR	26	17 177	1	1 000			2	3 606			1	5 250							30	27 033
SYR	17	14 376			1	1 200													18	15 576
MAR	10	10 265	1	400	3	1 404	4	1 510			1	100							19	13 679
PSE	8	10 976																	8	10 976
TOTAL	**1 447**	**6 011 425**	**117**	**569 632**	**204**	**406 841**	**85**	**159 736**	**104**	**118 263**	**34**	**112 603**	**9**	**57 510**	**9**	**8 641**	**25**	**80 986**	**2 034**	**7 525 637**

Source: GWI DesalData (2006)

Table 19 Daily output code

Code	Output (m^3/day)
1	50.000 and more
2	10.000 to 49.999
3	1.000 to 9.999
4	100 to 999
5	Unknown

Table 20 Mediterranean countries. Number and capacity of desalting plants according to daily output

Output code	1		3		2		4		5		TOTAL	
ISO code	**#**	**m^3/day**	**#**	**m^3/day**	**#**	**m^3/day**	**#**	**m^3/day**	**#**	**m^3/day**	**#**	**m^3/day**
ESP	12	981 400	181	586 384	31	622 252	191	76 061			415	2 266 097
DZA	9	1 341 688	69	176 917	8	182 700	59	25 037			145	1 726 342
ITA			113	336 581	20	345 296	188	69 950			321	751 827
ESP (IC)			103	302 721	19	360 600	166	67 107			288	730 428
ISR	2	413 270	27	112 065	4	64 432	14	5 771			47	595 538
EGY			105	260 779	7	75 732	295	106 631	2	Unknown	409	443 142
JOR	1	135 000	14	23 592	3	69 000	18	11 561			36	239 153
FRA	1	140 000	31	82 336			39	14 310			71	236 646
MLT			10	34 995	6	114 800	19	4 124			35	153 919
CYP	1	54 000	6	16 850	1	40 000	16	5 475			24	116 325
TUN			10	22 152	3	46 500	43	20 217			56	88 869
GRC			20	39 020	1	14 500	70	26 957			91	80 477
LBN			8	15 353	1	10 560	12	3 697			21	29 610
TUR			9	19 290			21	7 743			30	27 033
SYR			3	9 240			15	6 336			18	15 576
MAR			6	9 440			13	4 239			19	13 679
PSE			5	8 240			3	2 736			8	10 976
TOTAL	**26**	**3 065 358**	**720**	**2 055 955**	**104**	**1 946 372**	**1 182**	**457 952**	**2**	**Unknown**	**2 034**	**7 525 637**

Source: GWI DesalData (2006)

Table 21 Mediterranean countries. Number and capacity of desalting plants according to user category

User	Municipal		Industrial (captive)		Irrigation		Power		Tourism		Military		Discharge		Demonstration		Unknown		TOTAL	
ISO code	**#**	**m^3/day**	**#**	**m^3/day**	**#**	**m^3/day**	**#**	**m^3/day**	**#**	**m^3/day**	**#**	**m^3/day**	**#**	**m^3/day**	**#**	**m^3/day**	**#**	**m^3/day**	**#**	**m^3/day**
ESP	165	1 773 459	132	116 954	70	322 556	25	34 442	18	16 289	1	1 500	2	497	2	400			415	2 266 097
DZA	48	1 461 328	82	251 538			9	9 008	2	1 900	2	568					2	2 000	145	1 726 342
ITA	66	181 776	157	471 988	16	10 008	55	66 312	3	1 556	17	16 238	5	2 510	2	1 439			321	751 827
ESP (IC)	121	536 714	14	11 296	66	120 310	6	5 788	74	50 630	1	500			1	500	5	4 690	288	730 428
ISR	35	574 110	10	18 428							1	600			1	2 400			47	595 538
EGY	144	170 232	75	87 935			11	34 966	155	125 179	20	14 210	1	120			3	10 500	409	443 142
JOR	23	226 103	5	5 907	3	3 122	2	2 684	1	778	1	409					1	150	36	239 153
FRA	10	147 516	54	85 245			4	2 181	1	144	1	1 440	1	120					71	236 646
MLT	17	146 218	11	2 437			4	4 419	3	845									35	153 919
CYP	4	103 325	9	4 777			7	5 228			4	2 995							24	116 325
TUN	11	58 504	31	21 267	2	3 748	10	4 569	2	781									56	88 869
GRC	44	39 640	25	29 489			9	7 254	12	3 844	1	250							91	80 477
LBN	4	652	3	2 366			6	19 690	1	182							7	6 720	21	29 610
TUR	5	3 904	20	13 323			3	8 856	2	950									30	27 033
SYR	2	5 640	10	4 161			1	3 000	1	384	1	151		1 960			1	280	18	15 576
MAR	5	2 750	8	7 803			3	1 831	2	295							1	1 000	19	13 679
PSE	6	9 040					2	1 936											8	10 976
TOTAL	**710**	**5 440 911**	**646**	**1 134 914**	**157**	**459 744**	**157**	**212 164**	**277**	**203 757**	**50**	**38 861**	**11**	**5 207**	**6**	**4 739**	**20**	**25 340**	**2 034**	**7 525 637**

Source: GWI DesalData (2006)

4.2.2 Wastewater reuse

Seawater desalination increases the total amount of available water in the hydrological cycle but wastewater reuse does not. Reuse means that the same water is used repeatedly (after treatment to improve its conditions regarding its future use).

ICID (1996) says: *Wastewater generated by agricultural and urban sources can degrade water quality and must be considered when developing a river management system. Due to the high cost of transportation of waste-water to a disposal site (ocean, salt-sink or river discharge, etc.), this problem is not easily solved.* ***Maximum use of wastewater should be made before discharge****. At that time, disposal must be located in such a way that the river-basin water quality is protected and agricultural development is not jeopardized.*

Direct reuse: *The planned and deliberate use of* ***treated*** *wastewater for some beneficial purpose, such as irrigation, recreation, industry, the recharging of underground aquifers, and drinking.*

It seems that it is time to distinguish *wastewater*, *treated wastewater* and *regenerated water*, as it is done in the Spanish Royal Decree 1620/2007, to ensure not only quality adequacy with the planned uses, but also to mitigate or to remove the possible negative impacts.

Table 22 National population connected to waste water collecting system (% of national resident population, last year available)

Country	Year	Urban			Independent
		without treatment	with treatment	total	
CYP	2000	-	35	35	65
DZA	1998	62	4	66	
EGY	1996		45	45	
ISR	1999	11	89	100	
JOR	1997	-	52	52	48
MAR	1996	70		70	
MLT	2004	87	13	100	
PSE	2004			43	55
SYR	1994	49	10	59	
TUN	2001	6	39	45	
TUR	2004	26	37	63	

Source: EUROPEAN COMMISSION. EUROSTAT (2006, p. 74)

Table 23 indicates the minimum reduction, expressed in percentage, to be obtained after the primary, secondary and tertiary treatment. The sources are a) Council Directive 91/271/EEC of 21 May 1991 concerning urban waste-water treatment (OJ L 135, 1991-05-30, p. 40-52 and b) *Eurostat Yearbook 2004 Long term indicators*[11].

[11] http://epp.eurostat.cec.eu.int/portal/page?_pageid=1334,47410048,1334_47410079&_dad=portal&_schema=PORTAL (ENVIRONMENT and ENERGY > Environment > Water)

Table 23 Eurostat performing criteria for the three types of urban wastewater treatment

Treatment	BOD_5 reduction (% minimum)	COD reduction (% minimum)	TSS reduction (% minimum)	Nitrogen reduction (% minimum)	Phosphorus reduction (% minimum)	Faecal coliform concentration
Primary	20	---	50	---	---	---
Secondary	70	75	---	---	---	---
Tertiary	95	85	---	70	80	1.000/100 mL

Note that regarding the tertiary treatment, fulfilling one of three requisites (the nitrogen or phosphorus reduction or faecal coliform concentration) is enough.

Table 24 Number of waste water treatment plants and other related infrastructures (Last year available)

Type and/or location	Treatment	Country	Year	Number
Urban waste water treatment plants	Total	CYP	2000	30
		DZA	1998	48
		ISR	2002	89
		JOR	2000	32
		MLT	2004	1
		SYR	2001	5
		TUN	2001	65
		TUR	2004	165
	primary	ISR	2002	15
		MAR	1999	62
		TUR	2004	34
	secondary	ISR	2002	50
		MAR	1999	50
		TUR	2004	127
	tertiary	ISR	2002	24
		TUR	2004	4
Independent treatment		CYP	1999	400
Other waste water treatment	primary	CYP	1999	1
		DZA	1995	22
		TUR	1998	4
	secondary	TUR	1997	217
	tertiary	CYP	1991	1
		TUR	1998	2

Source: EUROPEAN COMMISSION. EUROSTAT (2006, p. 75)

Table 25 Waste water generated by domestic and industrial sector (hm^3). (Last year available)

Country	Sector	Year	Volume
CYP	domestic	1999	4
	industrial	1999	0
DZA	domestic	1998	1 275

Country	Sector	Year	Volume
	industrial	1997	288
ISR	domestic	1999	430
JOR	industrial	1998	17
MAR	domestic	1993	500
MLT	domestic	1990	21
	industrial	1990	3
TUN	domestic	2001	424
	industrial	2001	35
TUR	industrial	2004	3 112

Source: EUROPEAN COMMISSION. EUROSTAT (2006, p. 76)

4.2.3 Precipitation enhancement

Precipitation enhancement is one of the activities included under the broader concept of *weather modification* (defined as performing any activity with the intention of producing artificial changes in the composition, behaviour, or dynamics of the atmosphere). The term *precipitation* is used here as equivalent of "Liquid or solid products of the condensation of water vapour falling from clouds or deposited from air on the ground". Other weather modification activities are: hail suppression and fog dispersal.

The boundaries to this kind of activities are those of the *Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques.* Opened for signature at Geneva: 18th May 1977, Entered into force: 5th October 1978.

On the other hand, projects can lead to disputes between neighbouring countries in so far as transboundary damages are claimed.

4.2.4 Resources

4.2.4.1 Desalination

4.2.4.1.1 Organizations

- International Desalination Association (IDA). URL: http://www.idadesal.org
- European Desalination Society (EDS). URL: http://www.edsoc.com/
- Asociación Española de Desalación y Reutilización (AEDyR) (Spanish Desalination and Water Reuse Association). URL: http://http://www.aedyr.com/

4.2.4.1.2 Research

Research Centres

- Middle East Desalination Research Center (MEDRC): URL: http://www.medrc.org. The MEDRC has a Middle East and North Africa (MENA) University and Research Institution Outreach Program.

Table 28 is partly based on the Website: *MENA Universities and Research Institutions* (URL: http://www.medrc.org/directories/research_institutions.html). This Table includes a column with the *Parent organisation* of the *Research Centre*.

Table 26 Research organizations in NCWR

ISO code	Name	Parent organization	URL
EGY	Hydraulic Research Institute	National Water Research Center (NWRC)	
EGY	National Water Research Center (NWRC)	Ministry of Water Resources and Iirrigation	http://www.nwrc-egypt.org/
EGY	Ministry of Water Resources and Iirrigation	---	
ESP	Centro Canario del Agua	Fundación Centro Canario del Agua	http://www.fcca.es/
ISR	Zuckerberg Institute for Water Research (ZIWR)	Jacob Blaustein Institutes for Desert Research	http://w3.bgu.ac.il/ziwr/
ISR	Jacob Blaustein Institutes for Desert Research (BIDR)	Ben-Gurion University of the Negev	http://cmsprod.bgu.ac.il/Eng/units/bidr
ISR	Ben-Gurion University of the Negev	---	http://www.bgu.ac.il/
ISR	Stephen and Nancy Grand Water Research Institute (GWRI).	Technion-Israel Institute of Technology	http://gwri.technion.ac.il/
ISR	Technion-Israel Institute of Technology	---	http://www.technion.ac.il/
JOR	Institute of Land, Water And Environment	Hashemite University	http://www.rgs.hu.edu.jo/research/in_lwenv.html
JOR	Hashemite University	---	http://www.hu.edu.jo/
JOR	Queen Rania Al-Abdullah Center For Environmental Science and Technology	Jordan University of Science and Technology	http://www.just.edu.jo/center/index.aspx
JOR	Jordan University of Science and Technology	---	http://www.just.edu.jo
JOR	Environmental Research Center	Royal Scientific Society	http://www.rss.gov.jo/environment/testing.htm
JOR	Royal Scientific Society	---	http://www.rss.gov.jo/
JOR	Water and Environment Research and Study Center (WERSC)	University of Jordan	
JOR	University of Jordan	---	http://www.ju.edu.jo/
MAR	Laboratoire Biochimie, Biotechnologie et Environnement	Université Ibn Tofail	
MAR	Université Ibn Tofail	---	http://www.univ-ibntofail.ac.ma
PSE	Water Research Center	Al-Azhar University	
PSE	Al-Azhar University Gaza	---	http://www.alazhar.edu.ps (in Arabic)
TUN	Laboratoire Eau, Énergie et Environnement	Université de Sfax/Sfax University	
TUN	Université de Sfax/Sfax University	---	http://www.uss.rnu.tn/

Research Projects

The project listed below, following the call for proposals launched in 2002 in the framework of the Euro-Mediterranean regional programme for local water management (so called MEDA-Water), was awarded a grant contract from the European Commission[12].

Title	Countries	URL
ADIRA: Autonomous desalination system concepts for sea water and brackish water in rural areas with renewable energies	Denmark, Egypt, Spain, Greece, Jordan, Morocco, Oman & Turkey	http://www.adira.gr

[12] More information about MEDA Water Programme and the complete list of MEDA-Water projects (9) can be found at URL: http://www.medawater-rmsu.org/01/MedaWater%20Projects.htm.

4.2.4.1.3 Training

The Middle East Desalination Research Center (MEDRC) has desalination training programs which develop technical expertise and scientific skills throughout the Middle East. More information at URL: http://www.medrc.org/capacity/program_objectives.html.

4.2.4.1.4 Documentation

Databases

- *Desalination Directory Online*. URL: http://www.desline.com/. Claims "Over 21.000 entries. Over 17,000 individual owners, suppliers, users, academic, government, and industrial researchers, engineers, operators, managers, sales representatives, consultants. Over 4,500 Institutions, companies and associations".
- *DESALNET. Advanced Water Treatment Database*. American Water Works Association and US Bureau of Reclamation. 12 CD-ROMs. Bibliographical database including the publications issued by OSW/OWRT[13] (Research and Development Progress Reports), Water Treatment Technology Program (WTTP), Desalination and Water Purification Research and Development Program (DesalR&D Program), books, conference proceedings [ADA, NWSIA, AWWA, journals (Desalination, Journal AWWA, Water Science and Technology)].
- *IDA Worldwide Desalting Plants Inventory Report*. WANGNICK, K. 2004. 258 p. # 18.
- *19th IDA Worldwide Desalting Plant Inventory*. GLOBAL WATER INTELIGENCE (GWI) DesalData e IDA. 2006. Oxford: Media Analytics Ltd. CD-ROM.

Journals

Table 27 Some journals dealing with desalination

Name	ISSN	Publisher
Desalination	0011-9164 (Print)	Elsevier
International Desalination & Water Reuse Quarterly	1022-5404	Faversham House Group
International Journal of Nuclear Desalination	1741-9204 (Online) 1476 -914X (Print)	Inderscience Enterprises
Journal of Membrane Science	0376-7388	Elsevier

Proceedings of congresses:

A) International Desalination Association World Congresses

Table 30 indicates, in decreasing order, the IDA Congresses from 1983 to 2007.

Table 28 International Desalination Association World Congresses on Desalination and Water Reuse

Number	Year	Place	Theme
	2007	Gran Canaria, Spain	Desalination: Quenching a Thirst
	2005	Singapore	
---	2003	Paradise Island, Bahamas	Desalination: The Source of Sustainable Water Supplies
	2002	Manama, Bahrain	Desalination: Water For a Better Future
	1999	San Diego, California, USA	The Value of Water in the 21st Century
	1997	Madrid, Spain	Water is Essential for Life, Technology is Essential for Water
	1995	Abu Dhabi, U.A.E.	Water, Energy and Environment
	1993	Yokohama, Japan	Desalination and Water Treatment in Harmony with the Environment
	1991	Washington D.C., USA	Water the Challenge of the 90s
4th	1989	Kuwait City, Kuwait	Desalination in a Changing World
3rd	1987	Cannes, France	---
2nd	1985	Bermuda	---
1st	1983	Florence, Italy	---

B) EuroMed Conferences

Table 31 indicates the four EuroMed Conferences which took place until now.

Table 29 EuroMed Conferences

Year	Place	Theme
2006	Montpellier, France	Desalination Strategies in South Mediterranean Countries: Cooperation between Mediterranean Countries of Europe and the Southern Rim of the Mediterranean
2004	Marrakech, Morocco	Desalination Strategies in South Mediterranean Countries
2002	Sharm El Sheikh, Egypt	Technologies and Strategies
2000	Djerba, Tunisia	Desalination Strategies in South Mediterranean Countries

C) National Congresses of the Spanish Desalination and Water Reuse Association

Finally, Table 32 indicates the National Congresses of the Spanish Desalination and Water Reuse Association.

Table 30 National Congresses of the *Spanish Desalination and Water Reuse Association*

Date	Place	Number	Theme
2006-11-08/10	Palma de Mallorca	VI	BLANK
2004-11-24/25	Almería	V	La desalación al sur del mediterráneo (Desalination south of the Mediterranean)
2003-11-19/21	Las Palmas de Gran Canaria	IV	Desalación y reutilización. Mirando al futuro (Desalination and water reuse. Looking ahead)
2002-11-20/21	Málaga	III	Un recurso seguro (A reliable resource)
2001-11-21/22	Alicante	II	La Desalación y Reutilización del Siglo XXI (XXI century

Date	Place	Number	Theme
			Desalination and water reuse)
2000-11-	Murcia	I	La Desalación y Reutilización como Alternativa Real a la Sequía (Desalination and water reuse as a real alternative to drought)

The Nuclear Power Technology Development Section of the International Atomic Energy Agency (IAEA) includes at URL: http://www.iaea.org/NuclearPower/Desalination/Publications/ web page a list of publications related with Nuclear desalination, i. e. the use of nuclear energy as the energy source for the desalination process.

4.2.4.2 Wastewater reuse

4.2.4.2.1 Organizations

Organizations:

-
- FAO Regional Office for the Near East (URL: http://www.fao.org/world/Regional/RNE/index_en.htm)
- FAO Bureau Sous-Régional pour l'Afrique du Nord (SNEA) (http://www.fao.org/world/subregional/snea/index_fr.htm)
- WHO Regional Office for the Eastern Mediterranean (http://www.who.int/about/regions/emro/en/index.html)

Networks:

- Regional (Near East) Network on Waste Water Reuse. URL: http://www.fao.org/world/regional/rne/workpr/agricu/irriga/page58/page58_en.htm
- Mediterranean Network of Wastewater Reclamation and Reuse (Med-Reunet). URL: http://www.med-reunet.com/home.asp

4.2.4.2.2 Research

The International Water Management Institute (URL: http://www.iwmi.cgiar.org/) has established a Sub-Regional Office for Nile Basin and Eastern Africa towards the end of year 2003. Although IWMI home office is located in Sri Lanka and the Sub-regional Office for the Nile Basin and Eastern Africa is located in Ethiopia, Egypt being one of the ten countries of the Nile River Basin, with Djibouti, Somalia and Madagascar making up the Office activity area as well as the main research lines mean that it should be included.

Research Projects

Research projects funded by Euro-Mediterranean Regional Programme for Local Water Management (MEDA Water). (See Research Projects in 4.2.4.1.2)

Table 31 Research projects funded by MEDA Water

Title	Countries	URL
EMWATER: Efficient Management of Wastewater, its Treatment and Re-use in the Mediterranean countries.	Germany, Italy, Jordan, Lebanon, Palestine & Turkey	http://www.emwater.org
ZERØ M: Sustainable Concepts Towards a Zero Outflow Municipality.	Austria, Egypt, Germany, Italy, Morocco, Tunisia & Turkey	http://www.zer0-m.org/

4.2.4.2.3 Documentation

The documents related below have been issued by two specialized agencies of the United Nations (FAO and WHO) and one national environmental agency (U.S. EPA):

Table 32 Guidelines for water reuse

Year	Publisher	Author & title
2006	WHO	*WHO guidelines for the safe use of wastewater, excreta and greywater*. Geneva: World Health Organization. 4 vols. V. 1. *Policy and regulatory aspects*; v. 2. *Wastewater use in agriculture*; v. 3. *Wastewater and excreta use in aquaculture*; v. 4. *Excreta and greywater use in agriculture*. URL: http://www.who.int/water_sanitation_health/wastewater/gsuww/en/index.html
2004	EPA	*Guidelines for water reuse*. Environmental Protection Agency. 2004. xxviii+450 p. Ref: EPA/625/R-04/108. URL: http://www.epa.gov/ORD/NRMRL/pubs/625r04108/625r04108.htm
2003	FAO Regional Office for the Near Eas	FAO Regional Office for the Near East. 2003. *Users Manual For Irrigation With Treated Wastewater***.** Cairo: FAO RNE. URL: http://www.fao.org/world/Regional/rne/morelinks/Publications/English/Usersmanual-en.pdf
1992	FAO	PESCOD, M.B. *Wastewater treatment and use in agriculture*. Roma: FAO. 1992. XXX p. FAO irrigation and drainage paper 47. URL: http://www.fao.org/docrep/T0551E/t0551e00.htm

The five years (2004-2008) project Water Demand Initiative for the Middle East and North Africa (WaDImena). URL: http://www.idrc.ca/en/ev-66642-201-1-DO_TOPIC.html, has a webpage on bibliography about wastewater use: URL: http://www.idrc.ca/fr/ev-96374-201-1-DO_TOPIC.html.

In 2007, the Royal Decree 1620/2007 of 7 December, that lays down regulations for the reuse of treated wastewater (BOE 294 of 2007-12-08), has established the quality of regenerated water for Spain (defined as the wastewater that has been treated in a regenerative water plant). Table 34 indicates groups of uses (5), qualities (13) and uses (24). As far as we know, it is the first time that a country promulgates a legal standard for these characteristics.

Table 33 Regenerated water quality according to future uses

Group of uses	Quality	Use
1. Urban uses	1.1. Residential (domestic)	a) Irrigation of private gardens.
		b) Drainage of sanitary appliances.
	1.2. Services	a) Irrigation of urban green spaces (parks, sport fields and similar spaces).
		b) Street washing.
		c) Fire fighting systems.
		d) Industrial washing of vehicles.
2. Agricultural uses	2.1	a) Irrigation of crops with water application systems that allow direct contact between regenerated water and edible parts for feeding human beings with fresh products.
	2.2	a) Irrigation of products intended for human consumption with water application systems that do not avoid direct contact between regenerated water and edible parts, but the product is not fresh and requires later industrial treatment.
		b) Irrigation of grasslands for feeding animals for milk or meat production.
		c) Aquaculture.
	2.3	a) Localised irrigation of ligneous crops that prevents contact between regenerated water and fruit intended for human consumption.
		b) Irrigation of ornamental flowers, crop nurseries, greenhouses without direct contact between regenerated water and the products.
		c) Irrigation of industrial crops not intended for human consumption, crop nurseries, forage in silo, cereals and oilseeds.
3. Industrial uses	3.1	a) Process and cleaning waters except for food industry.
		b) Other industrial uses.
		c) Process and cleaning waters for food industry.
	3.2	a) Cooling towers and evaporation condensers.
4. Recreative uses	4.1	a) Irrigation of golf courses.
	4.2	a) Ponds, water bodies, and ornamental circulating flows, in which public access to water is forbidden.
5. Environmental uses	5.1	a) Aquifer recharge by localised percolation through the soil.
	5.2	a) Aquifer recharge by direct injection.
	5.3	a) Irrigation of forests, green spaces and others, that are not accessible to the public.
		b) Forestry.
	5.4	a) Other environmental uses (wetland conservation, minimum flow rates and others of the same type).

4.2.4.3 Precipitation enhancement

4.2.4.3.1 Organizations

- World Meteorological Organization (WMO). URL: http://www.wmo.int
- WMO. Atmospheric Research and Environment Programme. URL: http://www.wmo.int/web/arep/arep-home.html

- WMO. Weather Modification Programme (WMP)[14].
  URL:http://www.wmo.int/web/arep/wmp/wmp_homepage.shtml
- WMO Register of National Weather Modification Projects. URL:
  http://www.wmo.int/web/arep/wmp/wmp_register.shtml

4.2.4.3.2 Research

Research Projects

- Mediterranean, S-E. Europe and Middle East Precipitation Enhancement Project (MEDSEEME-PEP). URL: http://www.wmo.int/web/tco/MEDSEEMEPEP.pdf

4.2.4.3.3 Documentation

KAHAN, A.M. 1995. *Guidelines for Cloud Seeding to Augment Precipitation*. New York: ASCE. 145 p. ASCE Manual of Professional Practice No. 81.

THORNTON; J., Ed. 1998. *Sourcebook of Alternative Technologies for Freshwater Augmentation in Africa*. International Environmental Technology Centre (IETC). Technical Publication Series. URL: http://www.unep.or.jp/ietc/publications/techpublications/techpub-8a/index.asp#1

Weather Modification, Inc. Publications at URL: http://www.weathermod.com/publications.php

Table 34 Some journals dealing with weather modification

Name	ISSN	Publisher	URL
Journal of Weather Modification	0739-1781	Weather Modification Association	http://www.weathermodification.org/journal.htm
Journal of Applied Meteorology and Climatology	1558-8424	American Meteorological Society	http://www.ametsoc.org/PUBS/journals/jam

4.3 Analysis of the surveys

4.3.1 Answers received

Table 36 indicates answers received and their description regarding the level of completeness. The increasing order of complexity is indicated after.

1. NO ANSWER
2. YES. NO DATA = ANSWER BUT NO DATA
3. YES. NON VALID DATA = ANSWER WITH NON VALID DATA
4. YES = ANSWER WITH VALID DATA
5. YES + CASE STUDY = ANSWER WITH VALID DATA AND CASE STUDY

[14] Also called Physics of Clouds and Weather Modification Research Programme

Table 35 Survey answers by country, topic and level

Country (ISO 3166)	Desalination	Wastewater reuse	Precipitation enhancement
CYP	YES + CASE STUDY	YES	YES. NO DATA
DZA	NO ANSWER	NO ANSWER	NO ANSWER
EGY	NO ANSWER	NO ANSWER	NO ANSWER
ESP	YES	NO ANSWER	YES
FRA	NO ANSWER	NO ANSWER	NO ANSWER
GRC	YES + CASE STUDY	YES. NO DATA	YES
ISR	YES + CASE STUDY	YES	YES + CASE STUDIES
ITA	NO ANSWER	NO ANSWER	NO ANSWER
JOR	YES + CASE STUDY	YES	YES + CASE STUDY
LBN	YES. NO CHANGES	YES. PRELIMINARY STUDIES	YES. NONE
MAR	YES	YES	YES + CASE STUDY
MLT	YES	YES. NO DATA	YES. NON VALID DATA
PSE	NO ANSWER	NO ANSWER	NO ANSWER
SYR	NO ANSWER	NO ANSWER	NO ANSWER
TUN	NO ANSWER	NO ANSWER	NO ANSWER
TUR	YES	YES. NO DATA	NO ANSWER

4.3.2 Description per topic and country

4.3.2.1 Desalination

CYPRUS

Plants	Capacity (m^3/day)	Number
Total	102 094	8
Out of service	1 514	1
No data	700	1

Case study: Larnaca seawater desalting plant. Year of operation: 2001. Capacity: 54.000 m^3/day, average (10 years) load factor: 86,05 %. Energy consumption: 4,52 kWh/m^3 with water delivery at a distance of 12 km and 90 metres height.

GREECE

Plants	Capacity (m^3/day)	Number
Total	53 370	29
Out of service	-	-
No data	4 650	5

Case study: Island of Crete: 39 plants, total capacity: 9 985 m^3/day. Desalting seawater: four plants (2 130 m^3/day); desalting brackish water: 35 plants (7 855 m^3/day)

ISRAEL

Plants	Capacity (m^3/day)	Number
Total	868 425	50
Out of service	-	-
No data	-	-

Twelve plants treat water with high ion nitrate content.

Case study: Sabcha Eilat Brackish Water : Two Reverse Osmosis plants (A & B), total capacity: 36 000 m^3/day. Raw water: brackish water (TDS 5-6 kg/m^3 and 30 ^oC temperature). Energy consumption: 2,0 kWh/m^3

JORDAN

Plants	Capacity (m^3/day)	Number
Total	387 213	17
Out of service	-	-
No data	-	-

Case study: Ghor al-Safi plant: Reverse Osmosis plant. Design capacity: 1 680 m^3/day. Actual production: 3 120 m^3/day after mixing the water product (TDS < 0,070 kg/m^3) with 1.440 m^3/day of 0,9 kg/m^3 of brackish water. Raw water: 5,0 kg/m^3 .

Lesson learned: "*Water Authority of Jordan learned that enough and fresh data about quantity and quality of the raw water should be available before constructing any desalination plant*."

LEBANON

Plants	Capacity (m^3/day)	Number
Total	24 613	4
Out of service	-	-
No data	10 560	1

No case study**.**

MALTA

Plants	Capacity (m^3/day)	Number
Total	174 213	14
Out of service	-	-
No data	-	-

No case study.

MOROCCO

Plants	Capacity (m^3/day)	Number
Total	21 335	10
Out of service	-	-
No data	-	-

All desalting plants are in the Atlantic side of Morocco. Six of them are installed in Western Sahara.

SPAIN

Plants	Capacity (m^3/day)	Number
Total	3 397 471	852
Out of service	20 000	7-
No data	-	18-

In addition to the above table, Table 11 is included to detail the information. This Table summarises the situation in Spain on 31 December 2005. Some variables were taken into account to obtain an overall vision (the capital letters correspond to those of the first column of the Table):

A) Situation in the life cycle: pre-operational, operational and post-operational.

B) Geographic situation: Peninsula (total), peninsula (Mediterranean coast), Balearic Islands, North African Territories and Canary Islands.

C) Desalination process: RO (seawater or brackish water), EDR, VC, MSF and MED.

D) Ownership: public or private.

Table 36 Spain. Situation on 2005-12-31. Sea or brackish water desalting plants

Part	#	**Parameter**	**Number**	**Capacity (m^3/day)**
A	01	Desalting plants (Past, present & future)	870	NA
A	02	Desalting plants. No capacity data	18	NA

Part	#	Parameter	Number	Capacity (m^3/day)
A	03	Desalting plants. Grand total	852	3 397 471
A	04	Desalting plants. Pre-operational.	31	1 450 200
A	05	Desalting plants. Operational.	814	1 927 271
A	06	Desalting plants. Post-operational.	7	20 000
B	01	Desalting plants in operation (Total). Peninsula	386	1 066 731
B	02	Desalting plants in operation (Seawater). Peninsula	17	438 130
B	03	Desalting plants in operation (Total). Peninsula. Mediterranean coast	295	998 550
B	04	Desalting plants in operation (Seawater). Peninsula. Mediterranean coast	16	437 870
B	05	Desalting plants in operation (Total). Balearic Islands	33	150 946
B	06	Desalting plants in operation (Seawater). Balearic Islands	16	112 630
B	07	Desalting plants in operation (Total). North Africa Territories	5	29 290
B	08	Desalting plants in operation (Seawater). North Africa Territories	2	27 000
B	09	Desalting plants in operation (Total). Canary Islands	390	680 304
B	10	Desalting plants in operation (Seawater). Canary Islands	203	493 179
C	01	Desalting plants in operation. Process. RO seawater	195	938 709
C	02	Desalting plants in operation. Process. RO brackish water	547	763 562
C	03	Desalting plants in operation. Process. EDR	25	85 450
C	04	Desalting plants in operation. Process. VC	36	37 370
C	05	Desalting plants in operation. Process. MSF	3	55 200
C	06	Desalting plants in operation. Process. MED	3	39 600
C	07	Desalting plants in operation. Process unknown	5	7 380
D	01	Desalting plants in operation. Public. Total	122	1 168 914
D	02	Desalting plants in operation. Public. Seawater	78	886 260
D	03	Desalting plants in operation. Public. Brackish water	44	282 654
D	04	Desalting plants in operation. Private. Total	691	757 857
D	05	Desalting plants in operation. Private. Seawater	159	184 179
D	06	Desalting plants in operation. Private. Brackish water	532	573 678
D	07	Desalting plants in operation. Owner unknown.	1	500

TURKEY

There is only a small amount of desalination plants supplying water to some hotels in tourist areas.

4.3.2.2 Wastewater reuse

CYPRUS

The effluent of 5 wastewater treatment plants (totalling 51 000 m^3/day) is used for irrigation. A new approach is under way: Grey Water Treatment Plants at household level, based on the separation of grey and black waters and their treatment. The potential water saving is estimated to 2 hm^3/year.

ISRAEL

Israel has 53 wastewater treatment plants with a total capacity of 225,97 hm^3/year. There is a legal instrument (2000-01-07) giving a national target: to reuse 150 hm^3/year in 5 years.

JORDAN

The effluent of 17 (out of 19) wastewater treatment plants (166 700 m^3/day or 60,85 hm^3/year) is used in agriculture. A significant data: the TDS of treated water quality varies between 0,711 and 1,173 g/L.

MALTA

One plant. Capacity 7 000 m^3/day or 2,5 hm^3/year.

Effluent used in agriculture and industry.

MOROCCO

Six plants (two blank). Capacity 14 250 m^3/day or 5,20 hm^3/year.

SPAIN

According to the Spanish White Paper on Water (2000, p. 170 - 172), Spain relied on more than 100 activities of direct reuse (in which the second use takes place after the first without any public incorporation), which implies an annual volume of 230 hm^3. On the other hand, the National Irrigation Plan at Horizon 2008 (2002, p. 136) gives a number of 16,664 hectares irrigated with the effluents of wastewater treatment plants, against an irrigated total of 3,344,637 hectares.

4.3.2.3 Precipitation enhancement

GREECE

1. Pilot programme project. 4 500 km^2. (2001).
2. Mornos and Voiotikos Kifissos river basins (1994)

ISRAEL

1. Four projects. Total area 18 000 km^2. Control area 9 500 km^2.
2. All four projects are considered *case study* and some figures about the positive effect are given.

JORDAN

1. Project area: 2 000 km^2. 12 years period.
2. *"Failure to increase rain in Jordan during the 10 years of operation. According to the contact person such a project is a waste of time & money"*.

MOROCCO

1. Al Ghait (*The efficient rain*) Project. 14 300 km^2. Since 1984.
2. Case study: 16/17 January 2006 cloud seeding.
3. Precipitation (Rainfall & snow) has been very important.

SPAIN

WMO sponsored the Precipitation Enhancement Project (PEP). 1976. The selected country was Spain, specifically the Duero river basin. The set of published reports (34) on the topic can be found at: URL

http://www.wmo.int/pages/prog/arep/wmp/documents/pepreports.pdf

The Objective # 1 was "To provide Members with reliable information about the probabilities of successful *artificial* intervention *in* meteorological processes with the object of increasing the amount of precipitation over an area of the order of 10.000 km^2.

The *size* of the area for the proposed project *(i.e.* the target and nearby control areas) should be somewhere around 50.000 km^2, a scale large enough to provide adequate evaluation of *scientific* feasibility and *economic* benefit, but small enough to permit the use of adequate methods for seeding and observations."

5 CONCLUSIONS

GENERAL

The study was carried out with few answers from the countries. Therefore, a question on the methodology used arose: Was the survey, made through EMWIS National Focal Points, the right method to obtain information? Given the results, the answer can hardly be affirmative. In any case, another related documentation, for example the two *Compendiums* (2003 and 2005) on the *Environmental statistics in the Mediterranean countries*, has the same characteristics as far as the answers (or their absence) are concerned.

So the analysis is mainly based on a desk research.

ON DESALINATION

Desalination is a perfectly established option, featuring large differences between countries. However, the economic and environmental aspects will have to be taken more and more into consideration, especially in the countries of the European Union, which have to apply the Directives: 2000/60/EC establishing a framework for Community action in the field of water policy (Article 9 on Cost Recovery in water utilities is fundamental) and 85/337/EEC on the assessment of the impacts of certain public and private projects on the environment.

Power aspects will have an increasing weight in decision making, not only due to the impact of energy on the cost of a cubic metre, but also due to obligations deriving from the United Nations Framework Convention on Climate Change and from the Kyoto Protocol.

ON WASTEWATER REUSE

There is no common legal framework for wastewater reuse (except in Spain, with the Royal Decree 1620/2007, and in Morocco, with the Decree 2-97-875 on sanitary sewage use. (B.O. 4558, 1998-02-05).

Only Jordan gives TDS in the effluent of wastewater treatment plants. This information can be relevant if the effluents from the wastewater treatment plants can contribute to increase salinity in the receiving water flows.

The conclusions of the Mediterranean Wastewater Reuse Working Group, which are provided in the *Mediterranean Wastewater Reuse Report* (2007.URL: http://www.semide.net/media_server/files/3/t/Final_report.doc), have an economic and therefore quantitative approach and provide a new approach to the topic of wastewater reuse.

ON PRECIPITATION ENHANCEMENT

Excerpts from World Meteorological Organization (WMO) *Statement on Status of Weather Modification* (Annex III) and *Guidelines for Advice and Assistance Related to the Planning of Weather Modification Activities* (Annex IV). (Abridged Final Report of the Fifty-Third Session of the Executive Council, 2001, p. 98).

> "a) Cloud, fog and precipitation climatologies should be established in all countries as vital information for weather modification and water resources studies and operations.
>
> b) Operational cloud seeding projects should be strengthened by allowing an independent evaluation of the results of seeding."

In 2007, the Management Group of the Commission for Atmospheric Sciences, during its Second Session (Oslo, Norway, 24-26 September 2007) approved three documents on Weather Modification: 1) *Executive Summary of the WMO Statement on Weather Modification, 2) WMO Statement on Weather Modification* and *3) Guidelines for the Planning of Weather Modification Activities.* (URL: http://www.wmo.int/pages/prog/arep/wmp/documents/WM_statement_guidelines_approved.pdf).

There are changes in the language used in the titles of both series of documents, which correspond, not only to the time passed, but also to the progress made. Point 6 of the *Guidelines*… says:

"6. Weather modification should be viewed as a part of an integrated water resources management strategy. Instant drought relief is difficult to achieve. In particular, if there are no clouds, precipitation cannot be artificially stimulated. It is likely that the opportunities for precipitation enhancement will be greater during periods of normal or above normal rainfall than during dry periods."

6 RECOMMENDATIONS

This "Recommendations" section, which could also be called "Suggestions for short-term actions" tries to go beyond the strict limits of the Survey… so that the detected gaps (see Table 4) are filled up with quality information. It should be clear that this quality information is not an aim in itself, but the first step of a process that aims, among other objectives:

1) To facilitate the exercise of the citizens' right to the information.

2) To facilitate decision-making at political, social and enterprise levels, increasing transparency and reducing uncertainties, in particular, through improved knowledge about legal and administrative processes to build & operate desalting plants or wastewater reuse systems (technical & environmental limitations).

3) To facilitate the correct operation of the systems for desalination, treatment and reuse of wastewater, and, in its case, the intensification of rainfall.

4) To incorporate environmental aspects in the process of decision-making, creation and operation of systems, including, for example, the implementation of Environmental Impact Assessment (individual projects) and Strategic Environmental Assessment (plans, programmes and policies) before launching desalination or wastewater treatment projects.[15]

The recommendations are the following:

1) To implement an EMWIS Information System on Desalination in the Mediterranean (EISDM) in coordination with the International Desalination Association, the European Desalination Association and/or other geographically neighbour countries concerned in desalination.

[15] Particular attention should be paid to the selection of the location to discharge the saline water (brine) from the desalination facilities, with an outlet either into the sea (possible effects on the oceanic posidonia (meadow) beds L. Del.) or into inland waters.

The information system could include a document entitled *Desalination for everybody. Facts & figures in the Mediterranean context white paper* that could allow regular update and possible publication on paper.

2) To implement an EMWIS Information System on Water Reuse in the Mediterranean (EISWRM).

Both Information Systems should work closely with MEDSTAT II, the Euro-Mediterranean regional programme of statistical cooperation (URL: http://ec.europa.eu/eurostat/medstat) and include, besides the project data, operational characteristics, i.e.

- Raw and product water quality (physical, chemical and biological parameters),
- Energy consumption (divided into raw water pumping, product water pumping, brine pumping and the very desalination process) according with raw water quality,
- Load factor or yearly productions,
- Product water uses, its quality and applicable standards and
- A Quality Assurance/Quality Control programme regarding the data and the information.

3) As regards wastewater reuse, it would be advisable to consider the creation of a training centre on a Mediterranean scale. The possible economic, health and environmental benefits are in its favour.

4) In the case of precipitation enhancement, cooperation research projects should be envisaged on a regional scale. The creation of a research centre does not seem feasible in the short or medium term.

5) To study the coupling desalination with wastewater treatment or viceversa in order to maximize either the percentage of desalted water reused after wastewater treatment or the quality of treated wastewater.

7 ANNEX 1. SURVEY ON NON-CONVENTIONAL WATER RESOURCES USES IN THE MEDITERRANEAN.

7.1 General introductory note

The geographical/administrative location of every project, facility or installation should be defined with maximum accuracy, i.e. giving both the location in the smallest administrative unit and the one that this belongs to.

The European Union Countries have at their disposal a useful tool: the Nomenclature of Territorial Units for Statistics (NUTS)[16].

The NUTS classification is hierarchical. It subdivides each Member State into NUTS level 1 territorial units, each of which is subdivided into NUTS level 2 territorial units, these in turn each being subdivided into NUTS level 3 territorial units.

Below the NUTS 3 level t two levels of Local Administrative Units[17] (LAU) have been defined. The upper LAU level (LAU level 1, formerly NUTS level 4) is defined for most, but not all of the countries. The second LAU level (formerly NUTS level 5) consists of 112 119 municipalities or equivalent units in the 25 EU Member States.

The names of the smallest administrative units are: for France "Communes", for Cyprus and Greece "Demoi/Koinotites", for Italy "Comuni", for Malta "Local councils ", and for Spain "Municipios".

The same accuracy is required to all Euro-Mediterranean Partners countries, in order to obtain precise data, even if the situation is something different: districts in Israel and Turkey, governorates (محافظات) in Egypt, Jordan, Lebanon and Tunisia, provinces in Morocco, and wilayas (ولايات) in Algeria.

7.2 Desalination

To make easier the task of filling in this section, an inventory (Microsoft Excel format) of desalting plants in each country (as 2003-12-31) can be found attached to this document. This inventory can act as a guide to update and improve the information (mainly the fields LOCATION[18], CUSTOMER and BUDGET).

Please note that this information is only for the use of the person who fills in this section and that, owing to copyright laws, should not be disclosed at any rate.

7.2.1 Inventory of results

Table 37 Contact info of the person filling in the desalination section

Code	Parameter	Value	Comment
1.1	Name		
1.2	Forename		
1.3	Title		
1.4	Organization		
1.5	Position		
1.6	E-mail		
1.7	Telephone		

[16] Regulation (EC) No 1059/2003 of the European Parliament and of the Council of 26 May 2003 on the establishment of a common classification of territorial units for statistics (NUTS) (Official Journal L 154 , 2003-06-21, p.0001-0041). Reference 32003R1059

[17] URL: http://europa.eu.int/comm/eurostat/ramon/nuts/lau_en.html

[18] Please do not forget to substitute "BLANK" in the field LOCATION for the correct name.

Code	Parameter	Value	Comment
1.8	Fax		

For every main topic (represented in boldface) only one answer is required.

Table 38 Information for the person filling the desalination section

Code	Parameter	Description/ comment	Code/Value
1.1	**Country**	The nation or the area where the desalination plant has been installed. Refer to 2.1	
1.2	**Location**	The place where the plant is	
1.3	**NUTS**		
1.4	**Total capacity**	The summarized daily output of all units of a plant (m^3/d).	
1.5	**Yearly production**	The summarized yearly output of all units of a plant (hm^3/y).	
1.6	**Energy consumption**	The energy consumption per unit of produced water (kWh/m^3)	
1.7	**Units**	The number of units.	
1.8	**Process**	**The main desalination process applied:**	
1.8.01		Electrodialysis	ED
1.8.02		Electrodionization	EDI
1.8.03		Freezing	FREEZE
1.8.04		Hybrid process	HYBRID
1.8.05		Multi-effect evaporation (not vapour compression)	ME
1.8.06		Multi-stage flash	MSF
1.8.07		Nanofiltration[19]	NF
1.8.08		Reverse osmosis	RO
1.8.09		Thermal process in general	THERMAL
1.8.10		Vapour compression (mechanical and thermal)	VC
1.8.11		All other processes	OTHER
1.9	**Equipment**	**The main equipment applied:**	
1.9.01		Evaporator, flash	FLASH
1.9.02		Evaporator, horizontal tube falling film	HTE
1.9.03		Evaporator, submerged tube	ST
1.9.04		Evaporator, vertical plate falling film	VPE
1.9.05		Evaporator, vertical tube falling film	VTE
1.9.06		Membrane type unknown	MTU
1.9.08		Membrane, dual	SW/FM
1.9.07		Membrane, dual plant	HFM/SWM
1.9.09		Membrane, flat	FM
1.9.10		Membrane, hollow fibre	HFM
1.9.11		Membrane, spiral wound	SWM
1.9.12		Membrane, tubular	TM
1.9.13		All other equipment	OTHER
1.10	**Feature**	**The most important features of a desalination plant:**	
1.10.01		Cooling	COOL
1.10.02		Energy recovery in RO plants	ER
1.10.03		Energy recovery with Francis turbine	ER/PUM
1.10.04		Energy recovery with Pelton turbine	ER/PEL

[19] It is understood that NF membranes are used for concentration of compounds with molecular weights from 15,6 to 125.

Code	Parameter	Description/ comment	Code/Value
1.10.05		Energy recovery with pressure exchanger	ER/PRE
1.10.06		Energy recovery with turbo charger	ER/CHA
1.10.07		Energy recovery with work exchanger	ER/WOR
1.10.08		Fluidized bed	FB
1.10.09		Forced circulation	FC
1.10.10		Powered, geothermal energy	GEOTHERM
1.10.11		Powered, solar energy	SOLAR
1.10.12		Powered, wind energy	WIND
1.10.13		Reversal polarization in electrodialysis plants	EDR
1.10.14		Stack, horizontal	HST
1.10.15		Stack, vertical	VST
1.10.16		Vapour compression, mechanical	MVC
1.10.17		Vapour compression, thermal	TVC
1.11	**Raw water quality**	**The quality of the untreated water. Expressed as Total Dissolved Solids (TDS) in mg/L or salinity[20]:**	
1.11.1		Brackish or inland water. 3.000 < TDS < 20.000	BRACKISH
1.11.2		Brine or concentrated seawater. 50.000 < TDS	BRINE
1.11.3		Pure water. TDS < 500	PURE
1.11.4		River or other saline water of low concentration. 500 <TDS < 3.000	RIVER
1.11.5		Seawater or concentrated seawater. 20.000 <TDS< 50.000	SEA
1.11.6		Quality unknown	UNKNOWN
1.11.7		Other raw water	WASTE
1.12	**Product water quality**	**The quality of the untreated water. Expressed in TDS or salinity[21]**	
1.13	**Brine discharge**	**The place where the brine is discharged.**	
2.14	**Use**	**The classification of the ultimate owner/use:**	
2.14.01		Demonstration purposes	DEMO
2.14.02		Discharge	DIS
2.14.03		Drinking water for military facilities	MIL
2.14.04		Drinking water for tourist facilities	TOUR
2.14.05		Drinking water, municipal	MUNI
2.14.06		Industrial or process water	INDU
2.14.07		Irrigation	IRR
2.14.08		Process water in power stations	POWER
2.14.09		Unknown	UNKNOWN
2.15	**Owner**	**The name of the ultimate customer**	
2.16	**Contraction year**	**The year in which the contract was signed[22]**	
2.17	**Operation year**	**The year in which the plant was commissioned**	
1.18	**Budget**	**Total budget in millions.**	
1.19	**Exact**	**Is the budget figure exact or not? Answers: Y (yes)/N (not)**	
1.20	**Currency**	**Specify currency[23]**	

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[20] For TDS see *Standard Methods for the Examination of Water and Wastewater* (1030 E); regarding Salinity íb. (2520 A).

[21] See note 20

[22] According with ISO 8601:2004 *Data elements and interchange formats -- Information interchange -- Representation of dates and times*. YYYY-MM-DD. URL: http://www.iso.org/iso/en/prods-services/popstds/datesandtime.html.

[23] Any currency is valid, but, for comparison purposes, use preferably United States dollars (USD).

Code	Parameter	Description/ comment	Code/Value
1.21	**Plant supplier**	**The supplier of the desalination plant or the enterprise in charge of engineering and supply** **Joint ventures are considered single companies**	
1.22	**Country of plant supplier**	**The country of the plant supplier**	
1.23	**Consultant**	**The consultant engineer or engineering firm**	
1.24	**Membrane supplier**	**The supplier of the membrane**	
1.25	**Additional info**	*Any additional information, such as:*	
1.25.01		Build, own, operate	BOO
1.25.02		Build, own, operate, transfer	BOOT
1.25.03		Dual purpose plant (power station XXX MW)	DPXXXMW
1.25.04		Enhanced oil recovery	EOR
1.25.05		Expansion of existing units	EXP
1.25.06		High purity water	HPW
1.25.08		Independent water and power project	IWPP
1.25.07		Independent water project	IWP
1.25.09		Joint venture	JV
1.25.10		Licenser	LI
1.25.13		Main consultant	MCO
1.25.12		Main contractor	MC
1.25.14		Main sub-supplier	MSS
1.25.11		Other membrane manufacturer	M
1.25.15		Out of use	OOU
1.25.16		Plant removed	PR

7.2.2 Ex-post evaluation of a case (Case study)

The ex-post evaluation is *the evaluation*[24] *of a operation after it has been completed.*

The intention is to understand the factors of success or failure, to assess the sustainability of results and impacts, and to draw conclusions.

This "learning from the past" pursues a closer revision of a relevant project to reveal the reasons of its success (or failure). In any case, every bit of information increasing the know-how in this field can help in writing guidelines about what-to-do or what-not-to do, thus assuring success in future developments.

We ask for the equivalent of an *executive summary,* not for a fully detailed evaluation, even though a more detailed information is required, as well as the information included in Table 38.

The new information (case study description) should include e.g. changes in objectives, budget and/or timing, problems encountered (technical, economical, administrative, etc.), solutions implemented and lessons learned.

In addition to the information about the case, it should be advisable to get the data of the Table 37 regarding the person with a deep knowledge of the case.

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[24] The systematic and objective assessment of an ongoing or completed operation, programme or policy, its design, implementation and results. The aim is to determine the relevance and fulfilment of objectives, as well as efficiency, effectiveness, impact and sustainability. (URL: http://documents.wfp.org/stellent/groups/public/documents/ko/mekb_glossary.pdf)

7.3 Wastewater reuse

Table 39 Contact info of the person filling in the wastewater reuse section

Code	Parameter	Value	Comment
3.1	Name		
3.2	Forename		
3.3	Title		
3.4	Organization		
3.5	Position		
3.6	E-mail		
3.7	Telephone		
3.8	Fax		

7.3.1 Legal framework

Is there any legislative act regarding the use of wastewater?

If the answer is YES, for each of them, please specify its title, date of publishing in the National Official Gazette and any other pertinent reference.

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7.3.2 Inventory of results

Table 40 Information for the person filling the wastewater reuse section

Code	Parameter	Description/ comment	Code/Value
2.1	**Country**	The nation or the area where the wastewater treatment plant has been installed. Refer to 2.1	
2.2	**Location**	The place where the plant is	
2.3	**NUTS**		
2.4	**Daily capacity**	The summarized daily volume treated (m^3/d).	
2.5	**Yearly capacity**	The summarized yearly volume treated (hm^3/y).	
2.6	**Lines**	The number of lines.	
2.7	**Treatment**	**The treatment applied See Table 23.**	
2.7.1		Primary	PRIM
2.7.2		Secondary	SEC
2.7.3		Tertiary	TER
2.7.4		All other treatment	OTHER
2.8	**Equipment**	**The main equipment applied:**	
2.8.1			

Code	Parameter	Description/ comment	Code/Value
2.8.2			
2.8.3			
2.8.4			
2.8.5			
2.9	**Feature**	**The most important features of a desalination plant:**	
2.9.01			
2.9.02			
2.9.03			
2.9.04			
2.9.05			
2.10	**Product water quality**	**The quality of the untreated water. Expressed in TDS or salinity[25]**	
2.11	**Sewage sludge treatment**	Treated sludge means: *sludge which has undergone biological, chemical or heat treatment, long-term storage or any other appropriate process so as significantly to reduce its fermentability and the health hazards resulting from its use* (Council Directive 86/278/EEC)	
2.12	**Sewage sludge disposal**	**The method used to dispose the sewage sludge**	
2.12.1		Land filling	LAND
2.12.21		Incineration	FIRE
2.12.3		Reuse in agriculture	SOIL
2.12.4		Other	OTHER
2.13	**Use of treated wastewater**	**The classification of the use:**	
2.13.01		Home consumption except drinking water	HOME
2.13.02		Urban uses and services:	URBAN
2.13.03		Irrigation (specify culture)	IRR
2.13.04		Aquiculture	AGR
2.13.05		Industrial. Cooling (specify industry)	INDU
2.13.06		Water bodies	BODY
2.13.07		Groundwater recharge	GRND
2.13.08		Other	OTHER
2.14	**Owner**	**The name of the ultimate customer**	
2.15	**Contraction year**	**The year in which the contract was signed[26]**	
2.16	**Operation year**	**The year in which the plant was commissioned**	
2.17	**Budget**	**Total budget in millions.**	
2.18	**Exact**	**Is the budget figure exact or not? Answers: Y (yes)/N (not)**	
2.19	**Currency**	**Specify currency[27]**	
2.20	**Contractor**	**The supplier of the wastewater treatment plant or the enterprise in charge of engineering and supply Joint ventures are considered single companies**	

[25] See note 20

[26] According with ISO 8601:2004 *Data elements and interchange formats -- Information interchange -- Representation of dates and times*. YYYY-MM-DD. URL: http://www.iso.org/iso/en/prods-services/popstds/datesandtime.html.

[27] Any currency is valid, but, for comparison purposes, use preferably United States dollars (USD).

Code	Parameter	Description/ comment	Code/Value
2.21	**Country of contractor**	**The country of the plant supplier**	
2.22	**Consultant**	**The consultant engineer or engineering firm**	
2.23	**Additional info**	Any additional information, such as:	
2.23.1		Irrigated area (ha)	
2.23.2		Other	

Please duplicate this table for each treatment plant.

7.3.3 Ex-post evaluation of a case (Case study)

See 7.2.2 for guidelines.

7.4 Precipitation enhancement

7.4.1 Inventory of results

Table 41 Contact info of the person filling in the precipitation enhancement section

Code	Parameter	Value	Comment
1.1	Name		
1.2	Forename		
1.3	Title		
1.4	Organization		
1.5	Position		
1.6	E-mail		
1.7	Telephone		
1.8	Fax		

For finished projects, please refer to the pertinent published reports. For ongoing projects not included in the WMO Register of National Weather Modification Projects, please indicate:

1. Project name
2. Organizations involved
3. Contact person (Name, forename, e-mail and telephone)
4. Type of activity: Research, development, operational
5. Project target area (km^2)
6. Project control area (km^2) (If applicable)
7. Period (years)
8. Total budget (specify currency)

9. Available information concerning the project.

7.4.2 Ex-post evaluation of a case (Case study)

See 7.2.2 for guidelines.

7.5 Other non-conventional water resources

Even though desalination, waste water reuse and precipitation enhancement cover a very broad scope of non-conventional water resources, it is true that the lacking of an accurate definition of "non-conventional water resources" leaves a open door allowing to the inclusion of new sources or techniques, like the use of fresh groundwater flowing directly into the sea.

These waters are not, strictly speaking, "non-conventional". The "non-conventionality" arises from the technology involved in its location (mainly infra-red aerial photography) and exploitation.

Nevertheless, any information regarding water resources that could be labelled "non conventional" is welcome. In this case, a "case study approach" is recommended".