

Non-conventional water resources uses study in the Mediterranean

Customer: Unité Technique du SEMIDE (Système Euro-Méditerranéen d'Information dans le
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Non-conventional water resources uses study in the Mediterranean.

1 Foreword.

This study will deal with the three topics considered in the terms of reference issued by EMWIS TU: desalination, water reuse and rainfall enhancement. The countries to be included in the survey will be 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 field: projects, programmes, plants, and other resources: organizations, research centres, and documents: databases, journals, newsletters, reports books, and proceedings, either in paper or electronic format.

After the evaluation of the survey, a more accurate and updated knowledge of the state of the non-conventional water resources in the Mediterranean will be available.

2 Methodology

The study will be performed through a double approach. The first one goes through a comprehensive analysis of the available documentation. The second way, in close connection with the former one, will use a questionnaire to obtain, not only field data but to improve, to update and even to modify the existing information.

3 Planning of the activities

The table below provides an overview on the status of the planned activities:

Table 1 Planning of the activities

Activities	Status
Collection of bibliographical resources, information on resource centres	Completed
Preparation for publication on EMWIS website	To be published in July 2005
Preparation of 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)	Started but will be completed at the end of the study
Inventory of existing and planned initiatives based on a survey among EMWIS NFP	Questionnaire to be completed by end of June 2005 Survey in July 2005
Review of the MPC individual policies	September 2005
Preparation of draft and final reports	September 2005

The results will be presented during an EMWIS conference. A first validation could take place with the NFP during the coordination seminar planned in September 2005

4 Overview

4.1 Desalination

The Table 2 displays a first draft of the situation of desalination. The final report will offer a greater detail, considering technologies, users, geographical variety, etc.

Table 2 Desalination in the Mediterranean

Country	Number of plants	Largest plant (m ³ /day)
Spain	287	165.000
Italy	132	36.000
Algeria	61	88.888
Egypt	55	11.732
Israel	33	395.000
Greece	29	14.500
France	24	140.000
Malta	14	27.600
Tunisia	13	22.500
Morocco	13	7.000
Jordan	9	145.344
Turkey	9	5.250
Cyprus	8	54.000
Lebanon	3	10.560
Syria	3	3.000
Palestine	3	2.000

Source: WANGNICK, 2004

The author says in the report " *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.*" However, considering the amount of missing data, misspelling of geographical names and other aspects, further improvement of data quality should be performed during the present study.

4.2 Wastewater reuse

Desalination increases the total amount of available water in the hydrological cycle but wastewater reuse does not. The same water is used repeatedly, after treatment to improve its conditions regarding its future use.

4.3 Rainfall enhancement

As a part of weather modification techniques

Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques

Opened for signature at Geneva: 18 May 1977, Entered into force: 5 October 1978

Depositary: Secretary-General of the United Nations

5 Resources

5.1 Desalination

5.1.1 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://www.aedyr.com/>

5.1.2 Research Centres

- Middle East Desalination Research Center (MEDRC): URL: <http://www.medrc.org.om>

5.1.3 Documents

5.1.3.1 Databases

- Desalination Directory Online. URL: <http://www.desline.com/>. "Over 18.000 entries"
- 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/OWRT¹ (Research and Development Progress Reports), (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.

5.1.3.2 Journals

Table 3 Some journals dealing with desalination

Name	Publisher	ISSN
Desalination	Elsevier	0011-9164 (Print)
International Journal of Nuclear Desalination	Inderscience Enterprises	1741-9204 (Online), 1476 -914X (Print)
Journal of Membrane Science	Elsevier	0376-7388

5.1.3.3 International Desalination Association World Congress

Table 4 International Desalination Association World Congress (World Congress on Desalination and Water Reuse)

Number	Year	Place	Theme
---	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 21 st 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
4 th	1989	Kuwait City, Kuwait	Desalination in a Changing World
3 rd	1987	Cannes, France	---
2 nd	1985	Bermuda	---
1 st	1983	Florence, Italy	---

5.1.3.4 EuroMed conferences

Table 5 EuroMed Conferences

Year	Place	Theme
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

5.1.3.5 Asociación Española de Desalación y Reutilización National Congress

Table 6 Asociación Española de Desalación y Reutilización National Congress

Non-conventional water resources uses study in the Mediterranean

Date	Place	Theme
2004-11-24/25	Almería	La desalación al sur del mediterráneo
2003-11-19/21	Las Palmas de Gran Canaria	Desalación y reutilización. Mirando al futuro
2002-11-20/21	Málaga	Un recurso seguro
2001-11-21/22	Alicante	La Desalación y Reutilización del Siglo XXI
2000-11-	Murcia	La Desalación y Reutilización como Alternativa Real a la Sequía

5.2 Wastewater reuse

5.2.1 Organizations

- Mediterranean Network of Wastewater Reclamation and Reuse (Med-Reunet). URL: <http://www.med-reunet.com/home.asp>

5.2.2 Research Centres

No Research Centre operating in the Mediterranean area has been found.

5.2.3 Documents

The documents related below have been issued by two specialized agencies of the United Nations and one environmental agency at country level:

Year	Publisher	Author & title
1989	WHO	MARA, D y CAIRNCROSS, S. <i>Guidelines for the Safe Use of Wastewater and Excreta in Agriculture and Aquaculture.</i>
1992	FAO	PESCOD, M.B. <i>Wastewater treatment and use in agriculture.</i> Roma: FAO. 1992. XXX p. FAO irrigation and drainage paper 47. URL: http://www.fao.org/docrep/T0551E/t0551e00.htm
2004	EPA	<i>Guidelines for water reuse.</i> Environmental Protection Agency. 2004. 445 p. Ref: EPA/625/R-04/108. URL: http://www.epa.gov/ORD/NRMRL/pubs/625r04108/625r04108.htm

In 2000, BLUMENTHAL, U.J., PEASEY, A., RUIZ-PALACIOS, G. y MARA, D. D. propped a revision of 1989 WHO Guidelines: *Guidelines for wastewater reuse in agriculture and aquaculture: recommended revisions based on new research evidence.* Water and Environmental Health London and Loughborough (WELL). 2000. 67 p. WELL Study. Task N° 68. part 1. URL: <http://www.lboro.ac.uk/well/resources/well-studies/full-reports-pdf/task0068i.pdf>.

5.3 Rainfall enhancement

5.3.1 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)². 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

5.3.2 Research Centres and Projects

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

5.3.3 Documents

THORNTON; J., Ed. *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>

6 Country profiles

7 Conclusions

To be completed.

8 Recommendations

To be completed.

² Also called [Physics of Clouds and Weather Modification Research Programme](#)

9 Acronyms

Table 7 Acronyms used

Acronym	Meaning	Comment
ADA	American Desalting Association. See AMTA	
AEDyR	Asociación Española de Desalación y Reutilización	
AMTA	American Membrane Technology Association	
AWWA	American Water Works Association	
EDS	European Desalination Society	
EU	European Union	
IDA	International Desalination Association	
ISO	International Organization for Standardization	http://www.iso.org/
ISSN	International Standard Serial Number	http://www.issn.org/
MPC	Mediterranean Partner Country	
NFP	National Focal Point	
NWSIA	National Water Supply Improvement Association	
OSW	Office of Saline Water	
OWRT	Office of Water Research and Technology	
TDS	Total Dissolved Solids	
UAE	United Arab Emirates	
WMO	World Meteorological Organization	
WTTP	Water Treatment Technology Program	

ANNEX A

Survey on non-conventional water resources uses in the Mediterranean.

Information on the person filling 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		
1.8	Fax		

10 Desalination

Code	Parameter	Comment
2.1	Country	The nation or the area where the desalination plant has been installed. Refer to 2.1
2.2	Location	The place where the plant has been installed ³ .
2.3	Total capacity	The summarized output of all units of a plant (m ³ /d).
2.4	Energy consumption	The energy consumption per unit of produced water (kWh/m ³)
2.5	Units	The number of units.
2.6	Process	The main desalination process applied.
2.6.01		Electrodialysis
2.6.02		Electrodionization
2.6.03		Freezing
2.6.04		hybrid process
2.6.05		multi-effect evaporation (not vapour compression)
2.6.06		multi-stage flash
2.6.07		Nanofiltration ⁴
2.6.08		reverse osmosis
2.6.09		thermal process in general
2.6.10		vapour compression (mechanical and thermal)
2.6.11		all other processes
2.7	Equipment	The main equipment applied.
2.7.01		evaporator, flash
2.7.02		evaporator, horizontal tube falling film
2.7.03		evaporator, submerged tube
2.7.04		evaporator, vertical plate falling film
2.7.05		evaporator, vertical tube falling film
2.7.06		membrane type unknown
2.7.07		membrane, dual
2.7.08		membrane, dual

³ NUTS 3 or below (Local Administrative Units) for EU countries. Districts (CY and IL), governorates (EG, JO, LB), local councils (MT), provinces (MA), wilaya (DZ) or below.

⁴ It is understood that NF membranes are used for concentration of compounds with molecular weights of 15, 6 to 125.

Code	Parameter	Comment
2.7.09		membrane, flat
2.7.10		membrane, hollow fibre
2.7.11		membrane, spiral wound
2.7.12		membrane, tubular
2.7.13		all other equipment
2.8	Feature	The most important features of a desalination plant.
2.8.01		Cooling
2.8.02		energy recovery (ER) in RO plants
2.8.03		ER with Francis turbine
2.8.04		ER with Pelton turbine
2.8.05		ER with pressure exchanger
2.8.06		ER with turbo charger
2.8.07		ER with work exchanger
2.8.08		fluidized bed
2.8.09		forced circulation
2.8.10		powered, geothermal energy
2.8.11		powered, solar energy
2.8.12		powered, wind energy
2.8.13		reversal polarization in electrodialysis plants
2.8.14		stack, horizontal
2.8.15		stack, vertical
2.8.16		vapour compression, mechanical
2.8.17		vapour compression, thermal
2.9	Feed water quality	The quality of the untreated water. Expressed in TDS or salinity. ⁵
2.10	User	The classification of the ultimate customer/use
2.10.01		demonstration purposes
2.10.02		Discharge
2.10.03		drinking water for military facilities
2.10.04		drinking water for tourist facilities
2.10.05		drinking water, municipal
2.10.06		industrial or process water
2.10.07		Irrigation
2.10.08		process water in power stations
2.10.09		Unknown
2.11	Product water quality	The quality of the untreated water. Expressed in TDS or salinity ⁶
2.12	Owner	The name of the ultimate customer
2.13	Contract year	The year in which the contract was signed. ⁷
2.14	Budget	Total budget. Specify currency ⁸ .
2.15	Operation year	The year in which the plant was commissioned.
2.16	Plant supplier	The supplier of the desalination plant or the enterprise in charge of engineering and supply. Joint ventures are considered single companies.
2.17	Consultant	The consultant engineer.
2.18	Brine discharge	The place where the brine is discharged
2.19	Membrane supplier	The supplier of the membrane.

⁵ For TDS see *Standard Methods for the Examination of Water and Wastewater* (1030 E); regarding Salinity ib. (2520 A).

⁶ See note 5

⁷ 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>.

⁸ Any currency is valid, but, for comparison purposes, use preferably United States dollars (USD).

Code	Parameter	Comment
2.20	Additional info	Any additional information, such as:
2.20.01		Build, own, operate
2.20.02		Build, own, operate, transfer
2.20.03		Dual purpose plant (power station XXX MW)
2.20.04		Enhanced oil recovery
2.20.05		Expansion of existing units
2.20.06		High purity water
2.20.08		Independent water and power project
2.20.07		Independent water project
2.20.09		Joint venture
2.20.10		Licenser
2.20.13		Main consultant
2.20.12		Main contractor
2.20.14		Main sub-supplier
2.20.11		Other membrane manufacturer
2.20.15		Out of use
2.20.16		Plant removed

Information on the person filling the wastewater reuse section⁹

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		

11 Wastewater reuse**A) Legal framework.**

There is any legislative act regarding the use of wastewater?

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

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B) Inventory of results

As the number of different uses of treated wastewater varies widely (See Table 8 Uses of treated wastewater), you are kindly requested to supply the pertinent information to identify clearly every application.

Table 8 Uses of treated wastewater

Home consumption except drinking water
Urban uses and services:
Irrigation (specify culture)
Aquiculture
Industrial. Cooling (specify industry)
Water bodies
Groundwater recharge
Other

A minimal set of data could be as follows: geographical data (including, if applicable, the river basin), yearly volume of water used, yearly volume of water mixed, surface irrigated (in hectares). A data subset should include data about the wastewater treatment plant: geographical data, wastewater treatment (primary, secondary or tertiary), yearly volume of treated wastewater and operator.

⁹ To fill if different from 0

Information on the person filling the rainfall 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		

12 Rainfall enhancement

For the 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. Contact person (Name, forename, e-mail and telephone)
 3. Type of activity: Research, development, operational
 4. Project target area (km²)
 5. Project control area (km²) (If applicable)
 6. Period (years)
 7. Total budget (specify currency)
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