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Regional Meeting of Experts to review the Draft Desalination and Dumping Protocol Guidelines

Greece, 4-6 April 2017

Agenda item 5: Updated Assessments of Dumping and Desalination Activities in the Mediterranean

Countries Questionnaires on Desalination Activities

D R A F T

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UNEP/MAP
Athens, 2017

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Questionnaire

Seawater desalination status in the Mediterranean Region

1. Introduction

Seawater desalination has for a long time been a major source of water in parts of the Mediterranean to meet water demands, supplying ca. 12 Mm³/day desalinated water in 2013. The desalination effort is expected to continue to increase. The MED POL Programme of UNEP/MAP is assessing now the implementation of its desalination guidelines published in 2004 and evaluating the state of play of the desalination section in the Mediterranean. The purpose is to produce an updated guideline and provide the Contracting Parties with adequate technical guidance to reduce to a minimum all environmental impacts. For this we would appreciate your collaboration in completing this short questionnaire.

2. General Questions

2.1. Country: **ALGERIA**

2.2. How many desalination plants are in operation in your country? **32 (2011)**

2.2.1. How many plants desalinate seawater? _____

2.2.2. How many plants desalinate brackish water? _____

2.2.3. How many plants have a production capacity >50,000 m³/day? **10 (ref 8)**

2.3. What is the total annual desalination installed capacity? **876 Mm³/year (2013)**

2.3.1. What is the total annual production of desalinated water? **693.5 Mm³/year (2014)**

2.3.2. What is the total annual production originating from seawater desalination? **85% (ref 7);
1,461,920m³/day, 533.6 Mm³/year**

2.4. Are there more desalination plants at the planning/construction stage? **Yes**

2.4.1. How many? **2, Jilel , Bejaia**_____

2.4.2. Total planned desalination production **200,000 m³/day**

2.4.3. Expected year for start of production _____

3. Detailed information for large size desalination plants (>10,000 m³/day, 3.65 Mm³/year production).
(Please copy table for additional columns).

	Plant Name	Plant Name	Plant Name	Plant Name	Plant Name	Plant Name
Name	Kahrama	El Hamma	Beni Saf	Fouka	Skikda	Souk Tleta
Year starting to operate	2006	2008	2009	2010	2010	2010
Location¹						
Desalination Technology²	MSF	RO	RO	RO	RO	RO
Production, m³/day	86,000	200,000	150,000	120,000	100,000	200,000
Method of brine discharge³						
Co- discharge with brine⁴						
Chemicals used in the desalination process⁵						
Coagulants						
Anti-Scalant						
Biocides						
Water Hardener						
Other						
Chemicals co-discharged with brine⁶						
Is there a marine monitoring program in place?						

¹Location: city, area

²Desalination technology: **RO**-Reverse Osmosis, **MSF**- Multi Stage Flash, **MED** - Multi Effect Distillation, **Other** – please add technology

³Method of Brine discharge: **OD**-Open discharge, **MO**- Marine outfall, **Other** – please add details

⁴Co-discharge with brine: Other discharges, for example, cooling waters from Electric power stations

⁵Please name the chemicals: i.e Coagulants – iron salts (**FE**); anti-scalant- polyphosphonates (Ppho), **If the identity of the chemical is unknown, please add yes or no**

⁶Please name the chemicals discharged with the brine

	Plant Name	Plant Name	Plant Name	Plant Name	Plant Name	Plant Name
Name	Magtaa					
Year starting to operate	2014					
Location¹						
Desalination Technology²	RO					
Production, m³/day	500,000					
Method of brine discharge³	MO					
Co- discharge with brine⁴						
Chemicals used in the desalination process⁵						
Coagulants						
Anti-Scalant						
Biocides						
Water Hardener						
Other						
Chemicals co-discharged with brine⁶						
Is there a marine monitoring program in place?						

4. References and historical data

1. http://www.fao.org/nr/water/aquastat/water_res/index.stm#cp

FAO: "Le dessalement de l'eau de mer a considérablement augmenté ces dernières années en passant d'une capacité de production de 47 000 m³/jour en 2002 à 1.9 millions m³/jour en 2014, soit près de 695 millions m³/an, par 10 grandes stations. La station d'El-Mactaa, près d'Oran, inaugurée fin 2014 dispose à elle seule d'une capacité de 500 000 m³/jour, soit l'une des plus grandes unités de dessalement par osmose inverse au monde, permettant la couverture à long terme des besoins de cinq millions de personnes en eau potable. Le dessalement a en effet fortement contribué à la sécurisation de l'approvisionnement en eau potable des villes côtières. "

2. FAO, Aquastat

613 Mm³/year (2012)

3. Khordagui, H.: Assessment of potential cumulative environmental impacts of desalination plants around the Mediterranean Sea, SWIM Final report, Activity 1.3.2.1, 2013.

Installed capacity in Algeria **in 2013** – 20% of total desalination in the Mediterranean – 876 Mm³/year (2,400,000 m³/day).

4. Report on water desalination status in the Mediterranean countries. Dr. J.C.Cuenca, IMIDA, Spain, 2013
http://www.imida.es/documents/13436/877249/06_REPORT_ON_WATER+DESALINATION.pdf/ae6203f4-68f9-4a37-b728-22b5d247909e

In 2011, 166 desalination plants were reported, 57 with total capacity of 1559,000 m³/day on line, 75 plants with total capacity of 141,000 m³/day presumed to be on line and 19 plants (with total capacity of 1331,500 m³/day) under construction.

5. Lattemann, S., Kennedy, M. D., Schippers, J. C., and Amy, G.: Chapter 2 Global Desalination Situation. In: Sustainability Science and Engineering, Isabel, C. E. and Andrea, I. S. (Eds.), Elsevier, 2010

Installed capacity **in 2008**: MSF (113,000 m³/day), MED (41,100 m³/day), RO (603,000 m³/day).

6. UNEP/MAP/MEDPOL: Sea Water Desalination in the Mediterranean: Assessment and Guidelines, MAP Technical Reports Series No. 139, UNEP/MAP, Athens, 2003.

In 2000, there were 32 operating plants with production capacity > 500 m³/day with a total of 36.8 Mm³/year (100,739 m³/day) installed capacity.

7. Drouiche, N., Ghaffour, N., Naceur, M. W., Mahmoudi, H., and Ouslimane, T.: Reasons for the Fast Growing Seawater Desalination Capacity in Algeria, Water Resour. Manage., 25, 2743-2754, 2011.

8. <https://www.ade.dz/index.php/projets-2/dessalement>

Le dessalement est ainsi une option majeure : les stations en réalisation ne sont-elles pas appelées à répondre aux besoins de plus d'un cinquième de la population ?

Les grandes stations

N°	Localisation	Capacité m3/j	Population à servir	Echéancier prévisionnel
01	Kahrama (Arzew)	90 000	540 000	En Exploitation
02	Hamma (Alger)	200 000	L' Algérois	En Exploitation
03	Skikda	100 000	666 660	En Exploitation
04	BeniSaf) A.Temouchent	200 000	1 333 320	En Exploitation
05	Mostaganem	200 000	1 333 320	En Exploitation
06	Douaouda (Alger Ouest)	120 000	666 660	En Exploitation
07	Cap Djenet (Alger Est)	100 000	666 660	En Exploitation
08	Souk Tleta (Tlemcen)	200 000	1 333 320	En Exploitation
09	Honaine (Tlemcen)	200 000	1 333 320	En Exploitation
10	Mactaa (Oran)	500 000	1 333 320	1er T 2014
11	El Tarf	50 000	-	-
12	Ténès	200 000	999 990	-
13	Oued Sebt (Tipaza)	100 000	-	-

Total Stations :13

Capacité m3/j : 2 260 000

Population : 11 873 220

Questionnaire Cyprus

Questionnaire

Seawater desalination status in the Mediterranean Region

1. Introduction

Seawater desalination has for a long time been a major source of water in parts of the Mediterranean to meet water demands, supplying ca. 12 Mm³/day desalinated water in 2013. The desalination effort is expected to continue to increase. The MED POL Programme of UNEP/MAP is assessing now the implementation of its desalination guidelines published in 2004 and evaluating the state of play of the desalination section in the Mediterranean. The purpose is to produce an updated guideline and provide the Contracting Parties with adequate technical guidance to reduce to a minimum all environmental impacts. For this we would appreciate your collaboration in completing this short questionnaire.

2. General Questions

2.1. Country: **CYPRUS**

2.2. How many desalination plants are in operation in your country? **4 (Operating under Contracts with Cyprus Government)**

2.2.1. How many plants desalinate seawater? **4**

2.2.2. How many plants desalinate brackish water? **0**

2.2.3. How many plants have a production capacity >50,000 m³/day? **3**

2.3. What is the total annual desalination installed capacity? **80.5 Mm³/year (2016)**

2.3.1. What is the total annual production of desalinated water?

48.7 Mm³/year (2011)

17.6 Mm³/year (2012)

10.7 Mm³/year (2013)

32.8 Mm³/year (2014)

38.1 Mm³/year (2015)

68.7 Mm³/year (2016)

2.3.2. What is the total annual production originating from seawater desalination? **100% (2016)**

2.4. Are there more desalination plants at the planning /construction stage? **YES**

2.4.1. How many? **1**

2.4.2. Total planned desalination production **15,000 m³/day**

2.4.3. Expected year for start of production **2019**

3. Detailed information for large size desalination plants (>10,000 m³/day, 3.65 Mm³/year production).
(Please copy table for additional columns).

	Plant Name	Plant Name	Plant Name	Plant Name	Plant Name	Plant Name
Name	Dhekelia	Larnaca	Vasilikos	Limassol		
Year starting to operate	1999	2015	2014	2014		
Location¹						
Desalination Technology²	RO	RO	RO	RO		
Production, m³/day	60,500	60,000	60,000	40,000		
Method of brine discharge³						
Co- discharge with brine⁴						
Chemicals used in the desalination process⁵						
Coagulants	ferric chloride	ferric sulfate	ferric sulfate	no		
Anti-Scalant	polyphosphonates	polyphosphonates	polyphosphonates	polyphosphonates		
Biocides	sodium hypochloride	sodium hypochloride	sodium hypochloride	sodium hypochloride		
Water Hardener	CO ₂ + Ca(OH) ₂	calcium carbonate	calcium carbonate	calcium carbonate		
Other						
Chemicals co-discharged with brine⁶						
	polyphosphonates	polyphosphonates	polyphosphonates	polyphosphonates		
Is there a marine monitoring program in place?	yes	no	yes	no		

¹Location: city, area

²Desalination technology: **RO**-Reverse Osmosis, **MSF**- Multi Stage Flash, **MED** - Multi Effect Distillation, **Other** – please add technology

³Method of Brine discharge: **OD**-Open discharge, **MO**- Marine outfall, **Other** – please add details

⁴Co-discharge with brine: Other discharges, for example, cooling waters from Electric power stations

⁵Please name the chemicals: i.e Coagulants – iron salts (**FE**) ; anti-scalant- polyphosphonates (Ppho), **If the identity of the chemical is unknown, please add yes or no**

⁶Please name the chemicals discharged with the brine

Questinaire Egypt

Questionnaire

Seawater desalination status in the Mediterranean Region

1. Introduction

Seawater desalination has for a long time been a major source of water in parts of the Mediterranean to meet water demands, supplying ca. 12 Mm³/day desalinated water in 2013. The desalination effort is expected to continue to increase. The MED POL Programme of UNEP/MAP is assessing now the implementation of its desalination guidelines published in 2004 and evaluating the state of play of the desalination section in the Mediterranean. The purpose is to produce an updated guideline and provide the Contracting Parties with adequate technical guidance to reduce to a minimum all environmental impacts. For this we would appreciate your collaboration in completing this short questionnaire.

2. General Questions– Only for plants along or near the Mediterranean Coast

2.1. Country: **EGYPT**

2.2. How many desalination plants are in operation in your country along or near the Mediterranean coast? _____

2.2.1. How many plants desalinate seawater? _____

2.2.2. How many plants desalinate brackish water? _____

2.2.3. How many plants have a production capacity >50,000 m³/day? _____

2.3. What is the total annual desalination installed capacity ?_ **307 Mm³/year (2013). Includes desalination in the Red Sea.**

2.3.1. What is the total annual production of desalinated water? **200 Mm³/year (2013). Includes desalination in the Red Sea.**

2.3.2. What is the total annual production originating from seawater desalination? _____

2.4. Are there more desalination plants at the planning/construction stage along the Mediterranean coast? **YES_**

2.4.1. How many? **1 Al Almein**

2.4.2. Total planned desalination production **150,000 m³/day** __

2.4.3. Expected year for start of production _____

3. Detailed information for large size desalination plants (>10,000 m³/day, 3.65 Mm³/year production) only along the Mediterranean Coast. (Please copy table for additional columns).

	Plant Name	Plant Name	Plant Name	Plant Name	Plant Name	Plant Name
Name						
Year starting to operate						
Location¹						
Desalination Technology²						
Production, m³/day						
Method of brine discharge³						
Co- discharge with brine⁴						
Chemicals used in the desalination process⁵						
Coagulants						
Anti-Scalant						
Biocides						
Water Hardener						
Other						
Chemicals co-discharged with brine⁶						
Is there a marine monitoring program in place?						

¹Location: city, area

²Desalination technology: **RO**-Reverse Osmosis, **MSF**- Multi Stage Flash, **MED** - Multi Effect Distillation, **Other** – please add technology

³Method of Brine discharge: **OD**-Open discharge, **MO**- Marine outfall, **Other** – please add details

⁴Co-discharge with brine: Other discharges, for example, cooling waters from Electric power stations

⁵Please name the chemicals: i.e Coagulants – iron salts (**FE**), anti-scalant- polyphosphonates (Ppho), **If the identity of the chemical is unknown, please add yes or no**

⁶Please name the chemicals discharged with the brine

4. References and historical data

1. http://www.fao.org/nr/water/aquastat/countries_regions/lby/index.stm

FAO: "Sea water desalination is concentrated in the coastal areas along the Mediterranean and Red Sea, where there is no other source of water, and for tourism resorts. In 2010, desalination plants produced around 200 million m³/year (ICARDA and AusAID, 2011)".

2. FAO, Aquastat

200 Mm³/year (2010)

3. Khordagui, H.: Assessment of potential cumulative environmental impacts of desalination plants around the Mediterranean Sea, SWIM Final report, Activity 1.3.2.1, 2013.

Installed capacity in Egypt **in 2013** – 7% of total desalination in the Mediterranean – 307 Mm³/year (840,000 m³/day). MAY INCLUDE DESALINATION ON THE RED SEA

4. Report on water desalination status in the Mediterranean countries. Dr. J.C.Cuenca, IMIDA, Spain, 2013

http://www.imida.es/documents/13436/877249/06_REPORT_ON_WATER+DESALINATION.pdf/ae6203f4-68f9-4a37-b728-22b5d247909e

In 2011, 385 desalination plants with total capacity of 542,000 m³/day were on line, 153 plants with total capacity of 141,400 m³/day were presumed to be on line and 39 plants (with total capacity of 196,500 m³/day) were under construction. Most of the plants are small. Seawater desalination comprised of 80% of the total desalination effort. INCLUDES DESALINATION IN THE RED SEA.

5. Lattemann, S., Kennedy, M. D., Schippers, J. C., and Amy, G.: Chapter 2 Global Desalination Situation. In: Sustainability Science and Engineering, Isabel, C. E. and Andrea, I. S. (Eds.), Elsevier, 2010

Installed capacity **in 2008**: MSF (10,500 m³/day), MED (4,132 m³/day), RO (8,756 m³/day). The location (Mediterranean or Red Sea) of the following desalination effort was unknown: MSF (6,530 m³/day), MED (11,990 m³/day), RO (89,352 m³/day).

6. UNEP/MAP/MEDPOL: Sea Water Desalination in the Mediterranean: Assessment and Guidelines, MAP Technical Reports Series No. 139, UNEP/MAP, Athens, 2003.

In 2000, there were 7 operating plants with production capacity > 500 m³/day with a total of 7.6 Mm³/year (20,860 m³/day) installed capacity.

Questionnaire France

Questionnaire
Seawater desalination status in the Mediterranean Region

1. Introduction

Seawater desalination has for a long time been a major source of water in parts of the Mediterranean to meet water demands, supplying ca. 12 Mm³/day desalinated water in 2013. The desalination effort is expected to continue to increase. The MED POL Programme of UNEP/MAP is assessing now the implementation of its desalination guidelines published in 2004 and evaluating the state of play of the desalination section in the Mediterranean. The purpose is to produce an updated guideline and provide the Contracting Parties with adequate technical guidance to reduce to a minimum all environmental impacts. For this we would appreciate your collaboration in completing this short questionnaire.

2. General Questions– Only for plants along or near the Mediterranean Coast

2.1. Country: **FRANCE**

2.2. How many desalination plants are in operation in your country along or near the Mediterranean coast? _____

2.2.1. How many plants desalinate seawater? _____

2.2.2. How many plants desalinate brackish water? _____

2.2.3. How many plants have a production capacity >50,000 m³/day? _____

2.3. What is the total annual desalination installed capacity? **77 Mm³/year (2011), mostly riverine water desalination.**

2.3.1. What is the total annual production of desalinated water? **13 Mm³/year (2013).**

2.3.2. What is the total annual production originating from seawater desalination? **10 %**

2.4. Are there more desalination plants at the planning/construction stage along the Mediterranean coast? _____

2.4.1. How many? _____

2.4.2. Total planned desalination production _____

2.4.3. Expected year for start of production _____

3. Detailed information for large size desalination plants (>10,000 m³/day, 3.65 Mm³/year production) only along the Mediterranean Coast. (Please copy table for additional columns).

	Plant Name	Plant Name	Plant Name	Plant Name	Plant Name	Plant Name
Name						
Year starting to operate						
Location ¹						
Desalination Technology ²						
Production, m ³ /day						
Method of brine discharge ³						
Co- discharge with brine ⁴						
Chemicals used in the desalination process⁵						
Coagulants						
Anti-Scalant						
Biocides						
Water Hardener						
Other						
Chemicals co-discharged with brine⁶						
Is there a marine monitoring program in place?						

¹Location: city, area

²Desalination technology: **RO**-Reverse Osmosis, **MSF**- Multi Stage Flash **MED** - Multi Effect Distillation, **Other** – please add technology

³Method of Brine discharge: **OD**-Open discharge, **MO**- Marine outfall, **Other** – please add details

⁴Co-discharge with brine: Other discharges, for example, cooling waters from Electric power stations

⁵Please name the chemicals: i.e Coagulants – iron salts (**FE**), anti-scalant- polyphosphonates (Ppho), **If the identity of the chemical is unknown, please add yes or no**

⁶Please name the chemicals discharged with the brine

4. References and historical data

1. http://www.fao.org/nr/water/aquastat/countries_regions/lby/index.stm

FAO: No data.

2. FAO, Aquastat

No data

3. Khordagui, H.: Assessment of potential cumulative environmental impacts of desalination plants around the Mediterranean Sea, SWIM Final report, Activity 1.3.2.1, 2013.

Installed capacity in France **in 2013** – 0.3% of total desalination in the Mediterranean – 13 Mm³/year (36,000 m³/day).

4. Report on water desalination status in the Mediterranean countries. Dr. J.C.Cuenca, IMIDA, Spain, 2013

http://www.imida.es/documents/13436/877249/06_REPORT_ON_WATER+DESALINATION.pdf/ae6203f4-68f9-4a37-b728-22b5d247909e

In 2011, 39 desalination plants with total capacity of 212,152 m³/day were on line and 23 plants with total capacity of 20,952 m³/day were presumed to be on line. Seawater desalination constituted 10% of the total desalination effort, and riverine water 71%. Most of the plants are small and medium size.

5. Lattemann, S., Kennedy, M. D., Schippers, J. C., and Amy, G.: Chapter 2 Global Desalination Situation. In: Sustainability Science and Engineering, Isabel, C. E. and Andrea, I. S. (Eds.), Elsevier, 2010

NO DATA

6. UNEP/MAP/MEDPOL: Sea Water Desalination in the Mediterranean: Assessment and Guidelines, MAP Technical Reports Series No. 139, UNEP/MAP, Athens, 2003.

NO DATA

Questionnaire Greece

Questionnaire

Seawater desalination status in the Mediterranean Region

1. Introduction

Seawater desalination has for a long time been a major source of water in parts of the Mediterranean to meet water demands, supplying ca. 12 Mm³/day desalinated water in 2013. The desalination effort is expected to continue to increase. The MED POL Programme of UNEP/MAP is assessing now the implementation of its desalination guidelines published in 2004 and evaluating the state of play of the desalination section in the Mediterranean. The purpose is to produce an updated guideline and provide the Contracting Parties with adequate technical guidance to reduce to a minimum all environmental impacts. For this we would appreciate your collaboration in completing this short questionnaire.

2. General Questions

2.1. Country: **GREECE**

2.2. How many desalination plants are in operation in your country? **157 (2011)**

2.2.1. How many plants desalinate seawater? _____

2.2.2. How many plants desalinate brackish water? _____

2.2.3. How many plants have a production capacity >50,000 m³/day? _____

2.3. What is the total annual desalination installed capacity? **44 Mm³/year (2013)**

2.3.1. What is the total annual production of desalinated water? **40 Mm³/year (2011)**

2.3.2. What is the total annual production originating from seawater desalination? **56 % (2011)**

2.4. Are there more desalination plants at the planning/construction stage? **Yes**

2.4.1. How many? **_Upgrade Almyros, Iraklion, Crete** _____

2.4.2. Total planned desalination production - **20,000 m³/day**

2.4.3. Expected year for start of production _____

3. Detailed information for large size desalination plants (>10,000 m³/day, 3.65 Mm³/year production).
(Please copy table for additional columns).

	Plant Name	Plant Name	Plant Name	Plant Name	Plant Name	Plant Name
Name						
Year starting to operate						
Location ¹						
Desalination Technology ²						
Production, m ³ /day						
Method of brine discharge ³						
Co- discharge with brine ⁴						
Chemicals used in the desalination process⁵						
Coagulants						
Anti-Scalant						
Biocides						
Water Hardener						
Other						
Chemicals co-discharged with brine⁶						
Is there a marine monitoring program in place?						

¹Location: city, area

²Desalination technology: **RO**-Reverse Osmosis, **MSF**- Multi Stage Flash, **MED** - Multi Effect Distillation, **Other** – please add technology

³Method of Brine discharge: **OD**-Open discharge, **MO**- Marine outfall, **Other** – please add details

⁴Co-discharge with brine: Other discharges, for example, cooling waters from Electric power stations

⁵Please name the chemicals: i.e Coagulants – iron salts (**FE**), anti-scalant- polyphosphonates (Ppho), **If the identity of the chemical is unknown, please add yes or no**

⁶Please name the chemicals discharged with the brine

4. References and historical data

1. http://www.fao.org/nr/water/aquastat/countries_regions/lby/index.stm

FAO: No data

2. FAO, Aquastat

No data

3. Khordagui, H.: Assessment of potential cumulative environmental impacts of desalination plants around the Mediterranean Sea, SWIM Final report, Activity 1.3.2.1, 2013.

Installed capacity in Greece **in 2013** – 1% of total desalination in the Mediterranean – 44 Mm³/year (130,000 m³/day).

4. Report on water desalination status in the Mediterranean countries. Dr. J.C.Cuenca, IMIDA, Spain, 2013

http://www.imida.es/documents/13436/877249/06_REPORT_ON_WATER+DESALINATION.pdf/ae6203f4-68f9-4a37-b728-22b5d247909e

In 2011, 157 desalination plants were reported on line for Greece with total capacity of 109,115 m³/day on line, and 35 plants with total capacity of 40,135 m³/day were presumed to be on line. Most of the plants are small. Seawater desalination consisted of 56% of the total desalination effort.

5. Lattemann, S., Kennedy, M. D., Schippers, J. C., and Amy, G.: Chapter 2 Global Desalination Situation. In: Sustainability Science and Engineering, Isabel, C. E. and Andrea, I. S. (Eds.), Elsevier, 2010

Installed capacity **in 2008**: MSF (10,080 m³/day), MED (11,620 m³/day), RO (22,519 m³/day).

6. UNEP/MAP/MEDPOL: Sea Water Desalination in the Mediterranean: Assessment and Guidelines, MAP Technical Reports Series No. 139, UNEP/MAP, Athens, 2003.

In 2000, there were 9 operating plants with production capacity > 500 m³/day and a total of 8 Mm³/year (21,840 m³/day) installed capacity.

7. Zotalis, K., Dialynas, E., Mamassis, N., and Angelakis, A.: Desalination Technologies: Hellenic Experience, Water, 6, 1134, 2014.

Questionnaire Israel

Questionnaire

Seawater desalination status in the Mediterranean Region

1. Introduction

Seawater desalination has for a long time been a major source of water in parts of the Mediterranean to meet water demands, supplying ca. 12 Mm³/day desalinated water in 2013. The desalination effort is expected to continue to increase. The MED POL Programme of UNEP/MAP is assessing now the implementation of its desalination guidelines published in 2004 and evaluating the state of play of the desalination section in the Mediterranean. The purpose is to produce an updated guideline and provide the Contracting Parties with adequate technical guidance to reduce to a minimum all environmental impacts. For this we would appreciate your collaboration in completing this short questionnaire.

2. General Questions– Only for plants along or near the Mediterranean Coast

2.1. Country: **ISRAEL**

2.2. How many desalination plants are in operation in your country along or near the Mediterranean Coast? **13**_____

2.2.1. How many plants desalinate seawater? **5**_____

2.2.2. How many plants desalinate brackish water? **8**_____

2.2.3. How many plants have a production capacity >50,000 m³/day? **5**_____

2.3. What is the total annual production of desalinated water? 637 Mm³/year

2.4. What is the actual total annual production originating from seawater desalination? **587 Mm³/year (1,608,000 m³/day, 92% of total desalination effort). Less in rainy years.**

2.5. Are there more desalination plants at the planning/construction stage along the Mediterranean coast? **Yes**

2.5.1. How many? **1**

2.5.2. Total planned desalination production - **100 Mm³/year**

2.5.3. Expected year for start of production - **Unknown**

3. Detailed information for large size plants (>10,000 m³/day, 3.65 Mm³/year production) only along the Mediterranean Coast . (Please copy table for additional columns).

	Plant Name	Plant Name	Plant Name	Plant Name	Plant Name	Plant Name
Name	Ashqelon	Via Maris	Hadera	Soreq	Ashdod	
Year starting to operate	2005	2007	2010	2013	2015	
Location¹	Ashqelon	Palmachim	Hadera	Palmachim	Ashdod	
Desalination Technology²	RO	RO	RO	RO	RO	
Production, m³/day	329,000	247,000	348,000	411,000	274,000	
Method of brine discharge³	OD	MO	OD	MO	MO	
Co- discharge with brine⁴	Cooling waters	no	Cooling waters	no	no	
Chemicals used in the desalination process⁵						
Coagulants	FE	Polymer		FE		
Anti-Scalant	Ppho	Ppho	Ppho	Ppho	Ppho	
Biocides	yes	yes	yes	yes	yes	
Water Hardener	yes	yes	yes	yes	yes	
Other	Membrane cleaning	Membrane cleaning	Membrane cleaning	Membrane cleaning	Membrane cleaning	
Chemicals co-discharged with brine⁶						
	Fe, Ppho	Ppho	Ppho	Ppho	Ppho	
Is there a marine monitoring program in place?	yes	yes	yes	yes	yes	

¹Location: city, area

²Desalination technology: **RO**-Reverse Osmosis, **MSF**- Multi Stage Flash , **MED** - Multi Effect Distillation, **Other** – please add technology

³Method of Brine discharge: **OD**-Open discharge, **MO**- Marine outfall, **Other** – please add details

⁴Co-discharge with brine: Other discharges, for example, cooling waters from Electric power stations

⁵Please name the chemicals: i.e Coagulants – iron salts (**FE**), ; anti-scalant- polyphosphonates (Ppho), **If the identity of the chemical is unknown, please add yes or no**

⁶Please name the chemicals discharged with the brine

4. References and historical data

1. http://www.fao.org/nr/water/aquastat/water_res/index.stm#cp

FAO: "Mekorot, Israel's national water supply company, has built and operated small- and medium-size desalination facilities in the southern part of the country since the 1960s. Eilat at the southern tip of the country by the Red Sea was the first city to use desalination. Some 29 small plants generate 25 million cubic meters of water per year, mainly from brackish water. A decision to desalinate on a larger scale was taken in 2000 as a result of Israel's growing water scarcity. The national goal is to produce 750 million m³/year of desalinated water in 2020 (MAE, 2005). In the near future a string of desalination plants along the Mediterranean coast will produce 400 million cubic meters per year. One large plant for the desalination of seawater was recently completed on the Mediterranean coast, and is now producing 115 million cubic meters a year of potable water (MITL, 2008). Using the reverse osmosis process, this plant is generating water for about 60 cents per cubic meter. All tenders issued for desalination facilities stipulate stringent threshold levels for water quality and provide incentives for even higher water qualities, especially in terms of chloride levels, in order to allow for irrigation without the attendant problem of soil salinity. In 2002, the total installed gross desalination capacity (design capacity) in Israel was 439 878 m³/day or 160.6 million m³/year (Wangnick Consulting, 2002)." DATA NOT UPDATED SINCE 2008

2. FAO, Aquastat

140 Mm³/year (2007).

3. Khordagui, H.: Assessment of potential cumulative environmental impacts of desalination plants around the Mediterranean Sea, SWIM Final report, Activity 1.3.2.1, 2013.

Installed capacity in Israel **in 2013** – 18% of total desalination in the Mediterranean – 788 Mm³/year (2,1600,000 m³/day).

4. Report on water desalination status in the Mediterranean countries. Dr. J.C.Cuenca, IMIDA, Spain, 2013

http://www.imida.es/documents/13436/877249/06_REPORT_ON_WATER+DESALINATION.pdf/ae6203f4-68f9-4a37-b728-22b5d247909e

In 2011, 39 desalination plants with total capacity of 1124,712 m³/day on line, 11 plants with total capacity of 44,762 m³/day presumed to be on line and 4 plants (with total capacity of 911,000 m³/day) under construction. INCLUDES THE RED SEA.

5. Lattemann, S., Kennedy, M. D., Schippers, J. C., and Amy, G.: Chapter 2 Global Desalination Situation. In: Sustainability Science and Engineering, Isabel, C. E. and Andrea, I. S. (Eds.), Elsevier, 2010

Installed capacity **in 2008**: MED (17,000 m³/day), RO (441,000 m³/day).

6. UNEP/MAP/MEDPOL: Sea Water Desalination in the Mediterranean: Assessment and Guidelines, MAP Technical Reports Series No. 139, UNEP/MAP, Athens, 2003.

In 2000, there was 1 operating plant with production capacity > 500 m³/day with a total of 6.2 Mm³/year (17,000 m³/day) installed capacity.

7. <http://www.water.gov.il/Hebrew/about-reshut-hamaim/The-Authority/Pages/Desalination.aspx>

In Hebrew

Questionnaire Italy

Questionnaire

Seawater desalination status in the Mediterranean Region

1. Introduction

Seawater desalination has for a long time been a major source of water in parts of the Mediterranean to meet water demands, supplying ca. 12 Mm³/day desalinated water in 2013. The desalination effort is expected to continue to increase. The MED POL Programme of UNEP/MAP is assessing now the implementation of its desalination guidelines published in 2004 and evaluating the state of play of the desalination section in the Mediterranean. The purpose is to produce an updated guideline and provide the Contracting Parties with adequate technical guidance to reduce to a minimum all environmental impacts. For this we would appreciate your collaboration in completing this short questionnaire.

2. General Questions

2.1. Country: **ITALY**

2.2. How many desalination plants are in operation in your country?

2.2.1. How many plants desalinate seawater? _____

2.2.2. How many plants desalinate brackish water? _____

2.2.3. How many plants have a production capacity >50,000 m³/day? _____

2.3. What is the total annual desalination installed capacity ? **131 Mm³/year (2013)**

2.3.1. What is the total annual production of desalinated water?

2.3.2. What is the total annual production originating from seawater desalination? 52% of total production.

2.4. Are there more desalination plants at the planning/construction stage? _ _

2.4.1. How many? _ _ _____

2.4.2. Total planned desalination production -

2.4.3. Expected year for start of production _____

3. Detailed information for large size desalination plants (>10,000 m³/day, 3.65 Mm³/year production).
(Please copy table for additional columns).

	Plant Name	Plant Name	Plant Name	Plant Name	Plant Name	Plant Name
Name						
Year starting to operate						
Location¹						
Desalination Technology²						
Production, m³/day						
Method of brine discharge³						
Co- discharge with brine⁴						
Chemicals used in the desalination process⁵						
Coagulants						
Anti-Scalant						
Biocides						
Water Hardener						
Other						
Chemicals co-discharged with brine⁶						
Is there a marine monitoring program in place?						

¹Location: city, area

²Desalination technology: **RO**-Reverse Osmosis, **MSF**- Multi Stage Flash, **MED** - Multi Effect Distillation, **Other** – please add technology

³Method of Brine discharge: **OD**-Open discharge, **MO**- Marine outfall, **Other** – please add details

⁴Co-discharge with brine: Other discharges, for example, cooling waters from Electric power stations

⁵Please name the chemicals: i.e Coagulants – iron salts (**FE**); anti-scalant- polyphosphonates (Ppho), **If the identity of the chemical is unknown, please add yes or no**

⁶Please name the chemicals discharged with the brine

4. References and historical data

1. http://www.fao.org/nr/water/aquastat/countries_regions/lby/index.stm

FAO: No data.

2. FAO, Aquastat

No data

3. Khordagui, H.: Assessment of potential cumulative environmental impacts of desalination plants around the Mediterranean Sea, SWIM Final report, Activity 1.3.2.1, 2013.

Installed capacity in Italy **in 2013** –3% of total desalination in the Mediterranean – 131 Mm³/year (360,000 m³/day).

4. Report on water desalination status in the Mediterranean countries. Dr. J.C.Cuenca, IMIDA, Spain, 2013

http://www.imida.es/documents/13436/877249/06_REPORT_ON_WATER+DESALINATION.pdf/ae6203f4-68f9-4a37-b728-22b5d247909e

In 2011, 195 desalination plants with total capacity of 361,588 m³/day were on line and 124 plants with total capacity of 373,333 m³/day were presumed to be on line. Seawater desalination constituted 52% of the total desalination effort.

5. Lattemann, S., Kennedy, M. D., Schippers, J. C., and Amy, G.: Chapter 2 Global Desalination Situation. In: Sustainability Science and Engineering, Isabel, C. E. and Andrea, I. S. (Eds.), Elsevier, 2010

Installed capacity **in 2008**: MSF (84,930 m³/day), MED (87,100 m³/day), RO (97,723 m³/day).

6. UNEP/MAP/MEDPOL: Sea Water Desalination in the Mediterranean: Assessment and Guidelines, MAP Technical Reports Series No. 139, UNEP/MAP, Athens, 2003.

In 2000, there were 64 operating plants with production capacity > 500 m³/day with a total of 129 Mm³/year (353,990 m³/day) installed capacity

Questionnaire Lebanon

Questionnaire

Seawater desalination status in the Mediterranean Region

1. Introduction

Seawater desalination has for a long time been a major source of water in parts of the Mediterranean to meet water demands, supplying ca. 12 Mm³/day desalinated water in 2013. The desalination effort is expected to continue to increase. The MED POL Programme of UNEP/MAP is assessing now the implementation of its desalination guidelines published in 2004 and evaluating the state of play of the desalination section in the Mediterranean. The purpose is to produce an updated guideline and provide the Contracting Parties with adequate technical guidance to reduce to a minimum all environmental impacts. For this we would appreciate your collaboration in completing this short questionnaire.

2. General Questions

2.1. Country: **LEBANON**

2.2. How many desalination plants are in operation in your country? **13**

2.2.1. How many plants desalinate seawater? _____

2.2.2. How many plants desalinate brackish water? _____

2.2.3. How many plants have a production capacity >50,000 m³/day? _____

2.3. What is the total annual desalination installed capacity ?_ **10.6 Mm³/year (2011)**

2.3.1. What is the total annual production of desalinated water? **8.8 Mm³/year (2013), 7.3 Mm³/year (2011)**

2.3.2. What is the total annual production originating from seawater desalination? **91% (2011); 18,263 m³/day, 6.7 Mm³/year**

2.4. Are there more desalination plants at the planning/construction stage?

2.4.1. How many? _____

2.4.2. Total planned desalination production _____

2.4.3. Expected year for start of production _____

3. Detailed information for large size desalination plants (>10,000 m³/day, 3.65 Mm³/year production).
(Please copy table for additional columns).

	Plant Name	Plant Name	Plant Name	Plant Name	Plant Name	Plant Name
Name						
Year starting to operate						
Location¹						
Desalination Technology²						
Production, m³/day						
Method of brine discharge³						
Co- discharge with brine⁴						
Chemicals used in the desalination process⁵						
Coagulants						
Anti-Scalant						
Biocides						
Water Hardener						
Other						
Chemicals co-discharged with brine⁶						
Is there a marine monitoring program in place?						

¹Location: city, area

²Desalination technology: **RO**-Reverse Osmosis, **MSF**- Multi Stage Flash **MED** - Multi Effect Distillation, **Other** – please add technology

³Method of Brine discharge: **OD**-Open discharge, **MO**- Marine outfall, **Other** – please add details

⁴Co-discharge with brine: Other discharges, for example, cooling waters from Electric power stations

⁵Please name the chemicals: i.e Coagulants – iron salts (**FE**); anti-scalant- polyphosphonates (Ppho), **If the identity of the chemical is unknown, please add yes or no**

⁶Please name the chemicals discharged with the brine

4. References and historical data

1. http://www.fao.org/nr/water/aquastat/countries_regions/lby/index.stm

FAO: No text

2. FAO, Aquastat

47.3 Mm³/year (2006)

3. Khordagui, H.: Assessment of potential cumulative environmental impacts of desalination plants around the Mediterranean Sea, SWIM Final report, Activity 1.3.2.1, 2013.

Installed capacity in Lebanon **in 2013** – 0.2% of total desalination in the Mediterranean – 8.8 Mm³/year (24,000 m³/day).

4. Report on water desalination status in the Mediterranean countries. Dr. J.C.Cuenca, IMIDA, Spain, 2013

http://www.imida.es/documents/13436/877249/06_REPORT_ON_WATER+DESALINATION.pdf/ae6203f4-68f9-4a37-b728-22b5d247909e

In 2011, 13 desalination plants with total capacity of 20,069 m³/day on line, and 7 plants with total capacity of 9,056 m³/day were presumed to be on line. Seawater desalination constituted 91% of the total effort.

5. Lattemann, S., Kennedy, M. D., Schippers, J. C., and Amy, G.: Chapter 2 Global Desalination Situation. In: Sustainability Science and Engineering, Isabel, C. E. and Andrea, I. S. (Eds.), Elsevier, 2010

NO DATA.

6. UNEP/MAP/MEDPOL: Sea Water Desalination in the Mediterranean: Assessment and Guidelines, MAP Technical Reports Series No. 139, UNEP/MAP, Athens, 2003.

In 2000, there were 61 operating plants with production capacity > 500 m³/day with a total of 5.5 Mm³/year (15,190 m³/day) installed capacity.

Questionnaire Libya

Questionnaire

Seawater desalination status in the Mediterranean Region

1. Introduction

Seawater desalination has for a long time been a major source of water in parts of the Mediterranean to meet water demands, supplying ca. 12 Mm³/day desalinated water in 2013. The desalination effort is expected to continue to increase. The MED POL Programme of UNEP/MAP is assessing now the implementation of its desalination guidelines published in 2004 and evaluating the state of play of the desalination section in the Mediterranean. The purpose is to produce an updated guideline and provide the Contracting Parties with adequate technical guidance to reduce to a minimum all environmental impacts. For this we would appreciate your collaboration in completing this short questionnaire.

2. General Questions

2.1. Country: **LIBYA**

2.2. How many desalination plants are in operation in your country? **400 (2011)**

2.2.1. How many plants desalinate seawater? **20**

2.2.2. How many plants desalinate brackish water? _____

2.2.3. How many plants have a production capacity >50,000 m³/day? **11**

2.3. What is the total annual desalination installed capacity ? **482 Mm³/year (2013)**

2.3.1. What is the total annual production of desalinated water? **70 Mm³/year (2012)**

2.3.2. What is the total annual production originating from seawater desalination? **92% (2011)**

2.4. Are there more desalination plants at the planning/construction stage? **YES**

2.4.1. How many? **13, Benghazi, Tripoli, Misrata, Elkhoms, Sirt, Elzwitina, Soussa, Abutaraba, Derna, Tobruk, Sobrata, Sahel Jafara.**

2.4.2. Total planned desalination production **1,265.000 m³/day**

2.4.3. Expected year for start of production _____

3. Detailed information for large size desalination plants (>10,000 m³/day, 3.65 Mm³/year production).
(Please copy table for additional columns).

	Plant Name	Plant Name	Plant Name	Plant Name	Plant Name	Plant Name
Name	Tobruk	Bomba	Derna	Soussa	Abutaraba	Zliten
Year starting to operate	2002	1988	2009	2009	2007	1992
Location¹						
Desalination Technology²	MED/TVC	MSF	MED/TVC	MED/TVC	MED/TVC	MSF
Production, m³/day	40,000	30,000	40,000	50,000	40,000	30,000
Method of brine discharge³						
Co- discharge with brine⁴						
Chemicals used in the desalination process⁵						
Coagulants						
Anti-Scalant	Btegard or Socolan					
Biocides						
Water Hardener						
Other						
Chemicals co-discharged with brine⁶						
Is there a marine monitoring program in place?						

¹Location: city, area

²Desalination technology: **RO**-Reverse Osmosis, **MSF**- Multi Stage Flash , **MED** - Multi Effect Distillation, **Other** – please add technology

³Method of Brine discharge: **OD**-Open discharge, **MO**- Marine outfall, **Other** – please add details

⁴Co-discharge with brine: Other discharges, for example, cooling waters from Electric power stations

⁵Please name the chemicals: i.e Coagulants – iron salts (**FE**), anti-scalant- polyphosphonates (Ppho), **If the identity of the chemical is unknown, please add yes or no**

⁶Please name the chemicals discharged with the brine

	Plant Name	Plant Name	Plant Name	Plant Name	Plant Name	Plant Name
Name	Zawiya	Zuwara	Zuwara	Khoms	Elzutina	Misrata Iron
Year starting to operate	2009	2006	2013	1982	1983	1987
Location¹	Zawiya					
Desalination Technology²	MED/TVC	MED	MED/TVC			
Production, m³/day	80,000	40,000	40,000	40,000	30,000	31,000
Method of brine discharge³						
Co- discharge with brine⁴						
Chemicals used in the desalination process⁵						
Coagulants						
Anti-Scalant						
Biocides						
Water Hardener						
Other						
Chemicals co-discharged with brine⁶						
Is there a marine monitoring program in place?						

	Plant Name	Plant Name	Plant Name	Plant Name	Plant Name	Plant Name
Name	Tobruk 2	Zuara	Derna 2	Zuara 2	Misrata Iron 2	Soussa 2
Year starting to operate	2001	1983	2009	2009	2009	2009
Location¹						
Desalination Technology²	MED					
Production, m³/day	40,000	40,000	40,000	40,000	100,000	40,000
Method of brine discharge³						
Co- discharge with brine⁴						
Chemicals used in the desalination process⁵						
Coagulants						
Anti-Scalant						
Biocides						
Water Hardener						
Other						
Chemicals co-discharged with brine⁶						
Is there a marine monitoring program in place?						

4. References and historical data

1. http://www.fao.org/nr/water/aquastat/countries_regions/lby/index.stm

FAO: "Desalination started in Libya in the early 1960s and installed capacity reached 226.3 million m³/year in 2006 for a total of more than 400 desalination plants, including 17 large ones (GEC, 2006). In 2012, the total desalinated water produced in Libya is estimated at 70 million m³/year aimed at municipal and industrial water demands and using both thermal and membrane technologies. Thermal desalination plants are located directly at electricity generation facilities".

2. FAO, Aquastat
70 Mm³/year (2012)

3. Khordagui, H.: Assessment of potential cumulative environmental impacts of desalination plants around the Mediterranean Sea, SWIM Final report, Activity 1.3.2.1, 2013.

Installed capacity in Libya **in 2013** – 11% of total desalination in the Mediterranean – 482 Mm³/year (1320,000 m³/day).

4. Report on water desalination status in the Mediterranean countries. Dr. J.C.Cuenca, IMIDA, Spain, 2013
http://www.imida.es/documents/13436/877249/06_REPORT_ON_WATER+DESALINATION.pdf/ae6203f4-68f9-4a37-b728-22b5d247909e

In 2011, 285 desalination plants were reported for Libya, 68 with total capacity of 488,000 m³/day on line, 75 plants with total capacity of 321,000 m³/day presumed to be on line and 2 plants (with total capacity of 80,000 m³/day) under construction.

5. Lattemann, S., Kennedy, M. D., Schippers, J. C., and Amy, G.: Chapter 2 Global Desalination Situation. In: Sustainability Science and Engineering, Isabel, C. E. and Andrea, I. S. (Eds.), Elsevier, 2010

Installed capacity **in 2008**: MSF (374,000 m³/day), MED (380,000 m³/day), RO (37,970 m³/day).

6. UNEP/MAP/MEDPOL: Sea Water Desalination in the Mediterranean: Assessment and Guidelines, MAP Technical Reports Series No. 139, UNEP/MAP, Athens, 2003.

In 2000, there were 61 operating plants with production capacity > 500 m³/day with a total of 215 Mm³/year (589,604 m³/day) installed capacity.

7. <http://www.marcopolis.net/gdcol-plans-to-increase-libyas-desalination-capacity-by-building-more-desalination-plants.htm>

Interview with the Chairman of the General desalination company of Libya (GDCOL), Mr. A. A. Elhassadi (2013).

8. Alabar. Mohamed (2016), Environment Impact Assessment on Distillation Plant Libya, Case Study: Tobruk Distillation Plant. First Scientific conference on Engineering & Environment. 22-23 May 2016 Tobruk, Libya

9. Ministry of Oil & Gas, 2014. Country paper, Tenth Arab Energy Conference, Energy & Arab Cooperation, Abu Dhabi. EAU.

10. Elglidi .Ageli , General Destillation Company of Libya, interview, 2017.

Questionnaire Malta

Questionnaire

Seawater desalination status in the Mediterranean Region

1. Introduction

Seawater desalination has for a long time been a major source of water in parts of the Mediterranean to meet water demands, supplying ca. 12 Mm³/day desalinated water in 2013. The desalination effort is expected to continue to increase. The MED POL Programme of UNEP/MAP is assessing now the implementation of its desalination guidelines published in 2004 and evaluating the state of play of the desalination section in the Mediterranean. The purpose is to produce an updated guideline and provide the Contracting Parties with adequate technical guidance to reduce to a minimum all environmental impacts. For this we would appreciate your collaboration in filling out this short questionnaire.

2. General Questions

2.1. Country: **MALTA**

2.2. How many seawater desalination plants are in operation in your country? _____

2.3. What is the total annual installed capacity of desalinated water?

87.6 Mm³/year (2013)

2.4. What is the actual total annual production of desalinated water?

Mm³/year

2.5. Are there more desalination plants at the planning/construction stage? _____

2.5.1. How many? _____

2.5.2. Total planned desalination production _____

2.5.3. Expected year for start of production _____

2.6. Are there brackish water desalination plants? _____ Annual capacity _____

3. Detailed information for large size desalination plants (>10,000 m³/day, 3.65 Mm³/year production).

	Plant Name	Plant Name	Plant Name	Plant Name	Plant Name	Plant Name
Name	Malta	Penbroke	Ghar Lapsi	Valetta		
Year starting to operate	2006	2007	2008	1967		
Location¹						
Desalination Technology²	RO	RO	RO	MSF		
Production, m³/day	40,500	36,000	50,000	35,000		
Method of brine discharge³						
Co- discharge with brine⁴						
Chemicals used in the desalination process⁵						
Coagulants						
Anti-Scalant						
Biocides						
Water Hardener						
Other						
Chemicals co-discharged with brine⁶						
Is there a marine monitoring program in place?						

¹Location: city, area

²Desalination technology: **RO**-Reverse Osmosis, **MSF**- Multi Stage Flash, **MED** - Multi Effect Distillation, **Other** – please add technology

³Method of Brine discharge: **OD**-Open discharge, **MO**- Marine outfall, **Other** – please add details

⁴Co-discharge with brine: Other discharges, for example, cooling waters from Electric power stations

⁵Please name the chemicals: i.e Coagulants – iron salts (**FE**); anti-scalant- polyphosphonates (Ppho), **If the identity of the chemical is unknown, please add yes or no**

⁶Please name the chemicals discharged with the brine

PLEASE COPY TABLE FOR ADDITIONAL COLUMNS.

4. References and historical data

1. http://www.fao.org/nr/water/aquastat/countries_regions/lby/index.stm

FAO: “The desalinated water (31.40 million m³) was all used for the provision of potable water in the public supply, which is equal to 65% of the total potable water supply. “

2. FAO, Aquastat

18.9 Mm³/year (2013)

3. Khordagui, H.: Assessment of potential cumulative environmental impacts of desalination plants around the Mediterranean Sea, SWIM Final report, Activity 1.3.2.1, 2013.

Installed capacity in Malta **in 2013** – 2% of total desalination in the Mediterranean – 87.6 Mm³/year (240,000 m³/day).

4. Report on water desalination status in the Mediterranean countries. Dr. J.C.Cuenca, IMIDA, Spain, 2013

http://www.imida.es/documents/13436/877249/06_REPORT_ON_WATER+DESALINATION.pdf/ae6203f4-68f9-4a37-b728-22b5d247909e

In 2011, 15 desalination plants with total capacity of 131,273 m³/day were on line and 16 plants with total capacity of 119,878 m³/day were presumed to be on line. Seawater desalination constituted 99% of the desalination effort.

5. Lattemann, S., Kennedy, M. D., Schippers, J. C., and Amy, G.: Chapter 2 Global Desalination Situation. In: Sustainability Science and Engineering, Isabel, C. E. and Andrea, I. S. (Eds.), Elsevier, 2010

Installed capacity **in 2008**: MED (4,200 m³/day), RO (186,920 m³/day).

6. UNEP/MAP/MEDPOL: Sea Water Desalination in the Mediterranean: Assessment and Guidelines, MAP Technical Reports Series No. 139, UNEP/MAP, Athens, 2003.

In 2000, there were 15 operating plants with production capacity > 500 m³/day with a total of 45.2 Mm³/year (123,868 m³/day) installed capacity.

Questionnaire Morocco

Questionnaire

Seawater desalination status in the Mediterranean Region

1. Introduction

Seawater desalination has for a long time been a major source of water in parts of the Mediterranean to meet water demands, supplying ca. 12 Mm³/day desalinated water in 2013. The desalination effort is expected to continue to increase. The MED POL Programme of UNEP/MAP is assessing now the implementation of its desalination guidelines published in 2004 and evaluating the state of play of the desalination section in the Mediterranean. The purpose is to produce an updated guideline and provide the Contracting Parties with adequate technical guidance to reduce to a minimum all environmental impacts. For this we would appreciate your collaboration in completing this short questionnaire.

2. General Questions – Only for plants along or near the Mediterranean Coast

2.1. Country: **MOROCCO**

2.2. How many desalination plants are in operation in your country along or near the Mediterranean coast? **None**

2.2.1. How many plants desalinate seawater?

None along the Mediterranean coast and 06 along the Atlantic coast.

2.2.2. How many plants desalinate brackish water?

None along the Mediterranean coast and 06 on the country.

2.2.3. How many plants have a production capacity >50,000 m³/day?

None

2.3. What is the total annual desalination installed capacity ?

33.4 Mm³/year

2.3.1. What is the total annual production of desalinated water?

2.3.2. What is the total annual production originating from seawater desalination?

11.3 Mm³/year

2.4. Are there more desalination plants at the planning/construction stage along the Mediterranean coast? **Yes**

2.4.1. How many? **One (EL Hoceima)**

2.4.2. Total planned desalination production **200 l/s**

2.4.3. Expected year for start of production : **End of 2018**

3. Detailed information for large size desalination plants (>10,000 m³/day, 3.65 Mm³/year production) only along the Mediterranean Coast. (Please copy table for additional columns).

	Plant Name
Name	El Hoceima
Year starting to operate	-
Location¹	El Hoceima North of Morocco
Desalination Technology²	RO (Reverse osmosis)
Production, m³/day	17280 m ³ /day
Method of brine discharge³	Driving with diffuser
Co- discharge with brine⁴	
Chemicals used in the desalination process⁵	
Coagulants	-
Anti-Scalant	Yes
Biocides	Yes
Water Hardener	~ 136 meq/l
Other	
Chemicals co-discharged with brine⁶	
Is there a marine monitoring program in place?	Yes At Different stages of the treatment process

¹Location: city, area

²Desalination technology: **RO**-Reverse Osmosis, **MSF**- Multi Stage Flash, **MED** - Multi Effect Distillation, **Other** – please add technology

³Method of Brine discharge: **OD**-Open discharge, **MO**- Marine outfall, **Other** – please add details

⁴Co-discharge with brine: Other discharges, for example, cooling waters from Electric power stations

⁵Please name the chemicals: i.e Coagulants – iron salts (**FE**); anti-scalant- polyphosphonates (Ppho), **If the identity of the chemical is unknown, please add yes or no**

⁶Please name the chemicals discharged with the brine

4. References and historical data

1. http://www.fao.org/nr/water/aquastat/water_res/index.stm#cp

FAO: "Actuellement, le recours au dessalement de l'eau de mer et à la déminéralisation des eaux souterraines saumâtres pour l'approvisionnement en eau potable des villes et des centres déficitaires est limité aux zones sahariennes du sud du Maroc. La capacité était d'environ 13.11 millions de m³ en 2011 (35 910 m³/jour dont 5 030 m³/jour de déminéralisation d'eau saumâtre; CSEC, 2014), mais devrait augmenter pour atteindre plus 100 millions de m³ en 2020, avec en particulier l'installation d'une usine à Agadir (Jariri, 2009), de Sidi Ifni et de Tantan (10 000 m³/jour) (CES, 2014) et 400 millions de m³ en 2030 selon la stratégie nationale de l'eau (Plan Bleu, 2011)." MOSTLY IN THE ATLANTIC COAST

2. FAO, Aquastat

7 Mm³/Year (2008)

3. Khordagui, H.: Assessment of potential cumulative environmental impacts of desalination plants around the Mediterranean Sea, SWIM Final report, Activity 1.3.2.1, 2013.

Installed capacity in Morocco **in 2013** – 1% of total desalination in the Mediterranean – 43.8 Mm³/year (120,000 m³/day). MAY INCLUDE DESALINATION OF ATLANTIC SEAWATER.

4. Report on water desalination status in the Mediterranean countries. Dr. J.C.Cuenca, IMIDA, Spain, 2013
http://www.imida.es/documents/13436/877249/06_REPORT_ON_WATER+DESALINATION.pdf/ae6203f4-68f9-4a37-b728-22b5d247909e

In 2011, 40 desalination plants were reported in Morocco, 15 with total capacity of 46,750 m³/day on line, 25 plants with total capacity of 38,721 m³/day presumed to be on line. Seawater desalination constituted 77% of the total desalination effort. MAY INCLUDE DESALINATION OF ATLANTIC SEAWATER.

5. Lattemann, S., Kennedy, M. D., Schippers, J. C., and Amy, G.: Chapter 2 Global Desalination Situation. In: Sustainability Science and Engineering, Isabel, C. E. and Andrea, I. S. (Eds.), Elsevier, 2010. DATA FOR 2008.

NO DATA FOR THE MEDITERRANEAN

6. UNEP/MAP/MEDPOL: Sea Water Desalination in the Mediterranean: Assessment and Guidelines, MAP Technical Reports Series No. 139, UNEP/MAP, Athens, 2003.

In 2000, there were 3 operating plants with production capacity > 500 m³/day with a total of 5.4 Mm³/year (14,802 m³/day) installed capacity.

7. El Azhar, F., Tahaikt, M., Zouhri, N., Zdeg, A., Hafsi, M., Tahri, K., Bari, H., Taky, M., Elamrani, M., and Elmidaoui, A.: Remineralization of Reverse Osmosis (RO)-desalted water for a Moroccan desalination plant: optimization and cost evaluation of the lime saturator post, Desalination, 300, 46-50, 2012.

Questionnaire Syria

Questionnaire

Seawater desalination status in the Mediterranean Region

1. Introduction

Seawater desalination has for a long time been a major source of water in parts of the Mediterranean to meet water demands, supplying ca. 12 Mm³/day desalinated water in 2013. The desalination effort is expected to continue to increase. The MED POL Programme of UNEP/MAP is assessing now the implementation of its desalination guidelines published in 2004 and evaluating the state of play of the desalination section in the Mediterranean. The purpose is to produce an updated guideline and provide the Contracting Parties with adequate technical guidance to reduce to a minimum all environmental impacts. For this we would appreciate your collaboration in completing this short questionnaire.

2. General Questions

2.1. Country: **SYRIA**

2.2. How many desalination plants are in operation in your country? **8**

2.2.1. How many plants desalinate seawater? _____

2.2.2. How many plants desalinate brackish water? _____

2.2.3. How many plants have a production capacity >50,000 m³/day? _____

2.3. What is the total annual desalination installed capacity? **5.1 Mm³/year (2011)**

2.3.1. What is the total annual production of desalinated water? **2.9 Mm³/year (2011)**

2.3.2. What is the total annual production originating from seawater desalination? **2 % (2011)**

2.4. Are there more desalination plants at the planning/construction stage?

2.4.1. How many? _____

2.4.2. Total planned desalination production _____

2.4.3. Expected year for start of production _____

3. Detailed information for large size desalination plants (>10,000 m³/day, 3.65 Mm³/year production).
(Please copy table for additional columns).

	Plant Name	Plant Name	Plant Name	Plant Name	Plant Name	Plant Name
Name						
Year starting to operate						
Location¹						
Desalination Technology²						
Production, m³/day						
Method of brine discharge³						
Co- discharge with brine⁴						
Chemicals used in the desalination process⁵						
Coagulants						
Anti-Scalant						
Biocides						
Water Hardener						
Other						
Chemicals co-discharged with brine⁶						
Is there a marine monitoring program in place?						

¹Location: city, area

²Desalination technology: **RO**-Reverse Osmosis, **MSF**- Multi Stage Flash, **MED** - Multi Effect Distillation, **Other** – please add technology

³Method of Brine discharge: **OD**-Open discharge, **MO**- Marine outfall, **Other** – please add details

⁴Co-discharge with brine: Other discharges, for example, cooling waters from Electric power stations

⁵Please name the chemicals: i.e Coagulants – iron salts (**FE**); anti-scalant- polyphosphonates (Ppho), **If the identity of the chemical is unknown, please add yes or no**

⁶Please name the chemicals discharged with the brine

4. References and historical data

1. http://www.fao.org/nr/water/aquastat/countries_regions/lby/index.stm

FAO: No relevant text

2. FAO, Aquastat

No data

3. Khordagui, H.: Assessment of potential cumulative environmental impacts of desalination plants around the Mediterranean Sea, SWIM Final report, Activity 1.3.2.1, 2013.

Installed capacity in Syria in **2013** – 0% of total desalination in the Mediterranean

4. Report on water desalination status in the Mediterranean countries. Dr. J.C.Cuenca, IMIDA, Spain, 2013
http://www.imida.es/documents/13436/877249/06_REPORT_ON_WATER+DESALINATION.pdf/ae6203f4-68f9-4a37-b728-22b5d247909e

In 2011, 8 desalination plants with total capacity of 7,893 m³/day were on line and 6 plants with total capacity of 6,088 m³/day were presumed to be on line. Seawater desalination constituted 3% of the desalination effort.

5. Lattemann, S., Kennedy, M. D., Schippers, J. C., and Amy, G.: Chapter 2 Global Desalination Situation. In: Sustainability Science and Engineering, Isabel, C. E. and Andrea, I. S. (Eds.), Elsevier, 2010

NO DATA.

6. UNEP/MAP/MEDPOL: Sea Water Desalination in the Mediterranean: Assessment and Guidelines, MAP Technical Reports Series No. 139, UNEP/MAP, Athens, 2003.

NO DATA.

Questionnaire Tunisia

Questionnaire

Seawater desalination status in the Mediterranean Region

1. Introduction

Seawater desalination has for a long time been a major source of water in parts of the Mediterranean to meet water demands, supplying ca. 12 Mm³/day desalinated water in 2013. The desalination effort is expected to continue to increase. The MED POL Programme of UNEP/MAP is assessing now the implementation of its desalination guidelines published in 2004 and evaluating the state of play of the desalination section in the Mediterranean. The purpose is to produce an updated guideline and provide the Contracting Parties with adequate technical guidance to reduce to a minimum all environmental impacts. For this we would appreciate your collaboration in completing this short questionnaire.

2. General Questions

2.1. Country: **TUNISIA**

2.2. How many desalination plants are in operation in your country? **32 (2011)**

2.2.1. How many plants desalinate seawater? _____

2.2.2. How many plants desalinate brackish water? _____

2.2.3. How many plants have a production capacity >50,000 m³/day? _____

2.3. What is the total annual desalination installed capacity? **19.7 Mm³/year Brackish water desalination (2012), 8.8 Mm³/year seawater desalination (2013)**

2.3.1. What is the total annual production of desalinated water? **17.6 Mm³/year (2011)**

2.3.2. What is the total annual production originating from seawater desalination? **11% (2011); 9,900 m³/day, 3.6 Mm³/year**

2.4. Are there more desalination plants at the planning/construction stage? **Yes**

2.4.1. How many? **1 at Sfax** _____

2.4.2. Total planned desalination production **150,000 m³/day**

2.4.3. Expected year for start of production _____

3. Detailed information for large size desalination plants (>10,000 m³/day, 3.65 Mm³/year production).
(Please copy table for additional columns).

	Plant Name	Plant Name	Plant Name	Plant Name	Plant Name	Plant Name
Name	Kerkennah Brackish water	Gabès Brackish water	Zarzis Brackish water	Djerba Brackish water	Djerba Seawater	
Year starting to operate					2016	
Location¹						
Desalination Technology²					RO	
Production, m³/day					50,000	
Method of brine discharge³						
Co- discharge with brine⁴						
Chemicals used in the desalination process⁵						
Coagulants						
Anti-Scalant						
Biocides						
Water Hardener						
Other						
Chemicals co-discharged with brine⁶						
Is there a marine monitoring program in place?						

¹Location: city, area

²Desalination technology: **RO**-Reverse Osmosis, **MSF**- Multi Stage Flash, **MED** - Multi Effect Distillation, **Other** – please add technology

³Method of Brine discharge: **OD**-Open discharge, **MO**- Marine outfall, **Other** – please add details

⁴Co-discharge with brine: Other discharges, for example, cooling waters from Electric power stations

⁵Please name the chemicals: i.e Coagulants – iron salts (**FE**); anti-scalant- polyphosphonates (Ppho), **If the identity of the chemical is unknown, please add yes or no**

⁶Please name the chemicals discharged with the brine

4. References and historical data

1. http://www.fao.org/nr/water/aquastat/water_res/index.stm#cp

FAO: “Les ressources en eau non conventionnelles ont été prises en considération depuis les années 1970. Quatre stations de dessalement (Kerkennah, Gabès, Zarzis et Djerba) ont permis au volume d’eau saumâtre dessalée de passer de 13 millions de m³ en 2000 à 19.7 millions de m³ en 2012 (Eurostat, 2014). L’eau dessalée est destinée essentiellement à l’approvisionnement en eau potable des centres urbains dans la région du sud-est. Une vingtaine de nouvelles stations devraient être construites prochainement pour l’amélioration de la qualité des eaux dans le Sud tunisien pour une capacité totale de 68 700 m³/jour. De plus une station sur l’île de Djerba d’une capacité nominale de 50 000 m³/jour devrait être mise en service en 2016 pour le dessalement d’eau de mer cette fois (MEDD, 2009)”.

2. FAO, Aquastat

19.7 Mm³/year (2012)

3. Khordagui, H.: Assessment of potential cumulative environmental impacts of desalination plants around the Mediterranean Sea, SWIM Final report, Activity 1.3.2.1, 2013.

Installed capacity in Tunisia in **2013** – 0.1% of total desalination in the Mediterranean – 8.8 Mm³/year (24,000 m³/day).

4. Report on water desalination status in the Mediterranean countries. Dr. J.C.Cuenca, IMIDA, Spain, 2013

http://www.imida.es/documents/13436/877249/06_REPORT_ON_WATER+DESALINATION.pdf/ae6203f4-68f9-4a37-b728-22b5d247909e

In 2011, 56 desalination plants were reported, 32 with total capacity of 48,244 m³/day on line, 28 plants with total capacity of 45,032 m³/day presumed to be on line. Seawater desalination constituted 11% of the total effort, and the remaining was brackish water desalination.

5. Lattemann, S., Kennedy, M. D., Schippers, J. C., and Amy, G.: Chapter 2 Global Desalination Situation. In: Sustainability Science and Engineering, Isabel, C. E. and Andrea, I. S. (Eds.), Elsevier, 2010. DATA FOR 2008.

Installed capacity **in 2008**: MED (3,760 m³/day), RO (2,220 m³/day) – Total of 2.2 Mm³/year

6. UNEP/MAP/MEDPOL: Sea Water Desalination in the Mediterranean: Assessment and Guidelines, MAP Technical Reports Series No. 139, UNEP/MAP, Athens, 2003.

In 2000, there were 3 operating plants with production capacity > 500 m³/day with a total of 0.8 Mm³/year (2,220 m³/day) installed capacity.

Questinaire Turkey

Questionnaire

Seawater desalination status in the Mediterranean Region

1. Introduction

Seawater desalination has for a long time been a major source of water in parts of the Mediterranean to meet water demands, supplying ca. 12 Mm³/day desalinated water in 2013. The desalination effort is expected to continue to increase. The MED POL Programme of UNEP/MAP is assessing now the implementation of its desalination guidelines published in 2004 and evaluating the state of play of the desalination section in the Mediterranean. The purpose is to produce an updated guideline and provide the Contracting Parties with adequate technical guidance to reduce to a minimum all environmental impacts. For this we would appreciate your collaboration in completing this short questionnaire.

2. General Questions– Only for plants along or near the Mediterranean Coast

2.1. Country: **TURKEY**

2.2. How many desalination plants are in operation in your country? **57**

2.2.1. How many plants desalinate seawater? _____

2.2.2. How many plants desalinate brackish water? _____

2.2.3. How many plants have a production capacity >50,000 m³/day? _____

2.3. What is the total annual desalination installed capacity? **131 Mm³/year (2013). Mostly in the Marmara and Black Seas.**

2.3.1. What is the total annual production of desalinated water? **166 Mm³/year (2011)**

2.3.2. What is the total annual production originating from seawater desalination? **93% (2011).**

2.4. Are there more desalination plants at the planning/construction stage?

2.4.1. How many? _____

2.4.2. Total planned desalination production _____

2.4.3. Expected year for start of production _____

3. Detailed information for large size desalination plants (>10,000 m³/day, 3.65 Mm³/year production) only along the Mediterranean Coast. (Please copy table for additional columns).

	Plant Name	Plant Name	Plant Name	Plant Name	Plant Name	Plant Name
Name	Istanbul					
Year starting to operate	2005					
Location¹						
Desalination Technology²	RO					
Production, m³/day	25,000					
Method of brine discharge³						
Co- discharge with brine⁴						
Chemicals used in the desalination process⁵						
Coagulants						
Anti-Scalant						
Biocides						
Water Hardener						
Other						
Chemicals co-discharged with brine⁶						
Is there a marine monitoring program in place?						

¹Location: city, area

²Desalination technology: **RO**-Reverse Osmosis, **MSF**- Multi Stage Flash, **MED** - Multi Effect Distillation, **Other** – please add technology

³Method of Brine discharge: **OD**-Open discharge, **MO**- Marine outfall, **Other** – please add details

⁴Co-discharge with brine: Other discharges, for example, cooling waters from Electric power stations

⁵Please name the chemicals: i.e Coagulants – iron salts (**FE**); anti-scalant- polyphosphonates (Ppho), **If the identity of the chemical is unknown, please add yes or no**

⁶Please name the chemicals discharged with the brine

4. References and historical data

1. http://www.fao.org/nr/water/aquastat/countries_regions/lby/index.stm

FAO: No relevant text

2. FAO, Aquastat

0.5 Mm³/year (2008)

3. Khordagui, H.: Assessment of potential cumulative environmental impacts of desalination plants around the Mediterranean Sea, SWIM Final report, Activity 1.3.2.1, 2013.

Installed capacity in Turkey **in 2013** – 3% of total desalination in the Mediterranean – 131 Mm³/year (360,000 m³/day).

4. Report on water desalination status in the Mediterranean countries. Dr. J.C. Cuenca, IMIDA, Spain, 2013

http://www.imida.es/documents/13436/877249/06_REPORT_ON_WATER+DESALINATION.pdf/ae6203f4-68f9-4a37-b728-22b5d247909e

In 2011, 59 desalination plants were reported on line for Turkey, with total capacity of 457,000 m³/day on line, and 2 plants with total capacity of 11,628 m³/day presumed to be on line. MOST OF THE DESALINATION SEEMS TO BE IN THE MARMARA AND BLACK SEA. Seawater desalination accounted for 93% of the total desalination effort.

5. Lattemann, S., Kennedy, M. D., Schippers, J. C., and Amy, G.: Chapter 2 Global Desalination Situation. In: Sustainability Science and Engineering, Isabel, C. E. and Andrea, I. S. (Eds.), Elsevier, 2010

Installed capacity **in 2008**: MSF (1,000 m³/day), MED (8,640 m³/day), RO (30,850 m³/day), mostly in the Marmara Sea.

6. UNEP/MAP/MEDPOL: Sea Water Desalination in the Mediterranean: Assessment and Guidelines, MAP Technical Reports Series No. 139, UNEP/MAP, Athens, 2003.

NO DATA

Questionnaire State of Palestine

Questionnaire

Seawater desalination status in the Mediterranean Region

1. Introduction

Seawater desalination has for a long time been a major source of water in parts of the Mediterranean to meet water demands, supplying ca. 12 Mm³/day desalinated water in 2013. The desalination effort is expected to continue to increase. The MED POL Programme of UNEP/MAP is assessing now the implementation of its desalination guidelines published in 2004 and evaluating the state of play of the desalination section in the Mediterranean. The purpose is to produce an updated guideline and provide the Contracting Parties with adequate technical guidance to reduce to a minimum all environmental impacts. For this we would appreciate your collaboration in completing this short questionnaire.

2. General Questions

2.1. How many desalination plants are in operation in your country? **7**

2.1.1. How many plants desalinate seawater? **_1_**

2.1.2. How many plants desalinate brackish water? **_6_**

2.1.3. How many plants have a production capacity >50,000 m³/day? **_____**

2.2. What is the total annual desalination installed capacity? **___No data**

2.2.1. What is the total annual production of desalinated water? **4% of the total water demand (ref 7 and 8).**

2.2.2. What is the total annual production originating from seawater desalination? **_____**

2.3. Are there more desalination plants at the planning/construction stage? **_Yes_**

2.3.1. How many? **_Expansion of Central coast plant_**

2.3.2. Total planned desalination production - **additional 12,000 m³/day**

2.3.3. Expected year for start of production **_____**

3. Detailed information for large size desalination plants (>10,000 m³/day, 3.65 Mm³/year production).
(Please copy table for additional columns).

	Plant Name	Plant Name	Plant Name	Plant Name	Plant Name	Plant Name
Name						
Year starting to operate						
Location¹						
Desalination Technology²						
Production, m³/day						
Method of brine discharge³						
Co- discharge with brine⁴						
Chemicals used in the desalination process⁵						
Coagulants						
Anti-Scalant						
Biocides						
Water Hardener						
Other						
Chemicals co-discharged with brine⁶						
Is there a marine monitoring program in place?						

¹Location: city, area

²Desalination technology: **RO**-Reverse Osmosis, **MSF**- Multi Stage Flash, **MED** - Multi Effect Distillation, **Other** – please add technology

³Method of Brine discharge: **OD**-Open discharge, **MO**- Marine outfall, **Other** – please add details

⁴Co-discharge with brine: Other discharges, for example, cooling waters from Electric power stations

⁵Please name the chemicals: i.e Coagulants – iron salts (**FE**), anti-scalant- polyphosphonates (Ppho), **If the identity of the chemical is unknown, please add yes or no**

⁶Please name the chemicals discharged with the brine

4. References and historical data

1. http://www.fao.org/nr/water/aquastat/countries_regions/lby/index.stm

FAO: No data

2. FAO, Aquastat

No data

3. Khordagui, H.: Assessment of potential cumulative environmental impacts of desalination plants around the Mediterranean Sea, SWIM Final report, Activity 1.3.2.1, 2013.

No data

4. Report on water desalination status in the Mediterranean countries. Dr. J.C.Cuenca, IMIDA, Spain, 2013
http://www.imida.es/documents/13436/877249/06_REPORT_ON_WATER+DESALINATION.pdf/ae6203f4-68f9-4a37-b728-22b5d247909e

No data

5. Lattemann, S., Kennedy, M. D., Schippers, J. C., and Amy, G.: Chapter 2 Global Desalination Situation. In: Sustainability Science and Engineering, Isabel, C. E. and Andrea, I. S. (Eds.), Elsevier, 2010

No data

6. UNEP/MAP/MEDPOL: Sea Water Desalination in the Mediterranean: Assessment and Guidelines, MAP Technical Reports Series No. 139, UNEP/MAP, Athens, 2003.

No data.

7. Abualtayef, M., Al-Najjar, H., Mogheir, Y., and Seif, A. K.: Numerical modeling of brine disposal from Gaza central seawater desalination plant, Arabian Journal of Geosciences, 9, 572, 2016.

8. Mogheir, Y., Foul, A. A., Abuhabib, A. A., and Mohammad, A. W.: Assessment of large scale brackish water desalination plants in the Gaza Strip, Desalination, 314, 96-100, 2013.