DevelopMent AnD application of integrated technological and management solutions FOR wasteWATER treatment and efficient reuse in agriculture tailored to the needs of Mediterranean African Countries

Rapports

Informations projet

MADFORWATER

N° de convention de subvention: 688320

Financé au titre de
H2020-EU.3.5.
H2020-EU.3.5.4.

Budget total
€ 3 722 168,75

Contribution de l'UE
€ 2 910 868,75

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Date de début
1 Juin 2016

Date de fin
30 Novembre 2020

Ce projet apparaît dans...
Periodic Reporting for period 3 - MADFORWATER
(DevelopMent AnD application of integrated technological and management solutions FOR wasteWATER treatment and efficient reuse in agriculture tailored to the needs of Mediterranean African Countries)


Résumé du contexte et des objectifs généraux du projet

The Mediterranean African Countries (MACs) are characterized by a major water crisis. MADFORWATER focused on 3 MACs - Egypt, Morocco and Tunisia - representative of the North African Region in relation to their population, GDP and produced wastewater (WW).

MADFORWATER aimed at developing technological and management instruments for enhancing WW treatment, treated WW reuse for irrigation and water efficiency in agriculture in Egypt, Morocco and Tunisia.

This overall goal was translated into the following specific objectives:

1. improving the analysis of water and food security in the 3 target countries;
2. developing and adapting to the local contexts technologies for WW treatment and treated WW reuse for irrigation;
3. promoting business opportunities in the target countries for water & irrigation enterprises;
4. developing basin-scale water and land management strategies;
5. increasing the level of capacity building in the target countries in relation to the proposed solutions and the social acceptance of treated WW reuse in agriculture;
6. enabling the adaptation of the project outcomes to other basins of the target MACs.

The MADFORWATER concept is shown in Fig. 1.

Travail effectué depuis le début du projet jusqu’à la fin de la période considérée dans le rapport et principaux résultats atteints jusqu’à présent
The first objective of MADFORWATER was to improve the analysis of water and food security in Egypt, Morocco and Tunisia. For the first time, the 2016 Asian Water Development Outlook (AWDO) for quantifying economic water security was applied to Morocco, Tunisia and Egypt, leading to the identification of the sectors that contribute more intensely to the water vulnerabilities of each country. A mapping of wastewater reuse potential in the target MACs was elaborated (Fig. 2). The economic water security approach was applied also to the analysis of food security. This led to the production of two maps showing food security risk in Mediterranean countries, one referred to the current situation and one to a 20-year projection. This analysis led to the identification of measures to enhance water and food security in the 3 target countries.

The second objective was to develop a technological toolbox for WW treatment, irrigation efficiency and treated WW reuse in agriculture. MADFORWATER set up and adapted to the local contexts of Tunisia, Morocco and Egypt technologies for the treatment of different WW types, largely produced in these countries: municipal WW, water of drainage canals in the Nile delta, agro-industrial WWs and textile WW. Furthermore, the project developed and adapted to the 3 target countries 6 technologies suitable for irrigation with treated WW in hot climates. The most promising technologies were scaled-up and validated in 4 demonstrator plants of integrated WW treatment and reuse, installed in the 3 target countries and operated for over 1 year (Figs. 3-6). The 4 demos led to the production and reuse of high-quality effluents, and to the validation of several irrigation technologies under field conditions. In addition, MADFORWATER worked on the development of protocols for the detection and quantification of severe acute respiratory syndrome Coronavirus 2 (SARS-CoV-2) in raw and treated WW. Two methods for virus recovery and concentration were validated, and the development of a method for virus quantification in WW is in progress.

In order to promote business opportunities in the target countries (third objective), a business plan was developed for each MADFORWATER SME, and guidelines for the market expansion in the target MACs of for EU and North African water and irrigation companies were produced.

The fourth objective was to decrease water vulnerabilities in Egypt, Morocco and Tunisia through the development of sustainable water management strategies. Two model-based Decision Support Tools – dedicated to WW management and to agricultural water management – were developed and utilized to integrate the MADFORWATER technologies and economic instruments into basin-scale water & land management strategies adapted to the 3 hydrological (sub)basins targeted by the project: Souss-Massa in Morocco, Cap-Bon and Miliane in Tunisia, North-Eastern Nile Delta in Egypt (Fig. 7). A review on the policies and economic instruments applied in water management in the target MACs was produced and published.

In order to increase the level of capacity building in the target countries in the fields of water management and social acceptance of treated WW reuse (fifth objective), MADFORWATER organized in Morocco, Tunisia and Egypt several stakeholder consultation workshops, capacity building workshops, train-the-trainer courses and field visits. 32 scientific articles, a book on the project’s technologies and 4 newsletters were published. Various dissemination materials were translated in French and Arabic to ensure wider impact in North African countries.
MADFORWATER reached a relevant advancement beyond the state of the art in the fields of WW treatment, WW reuse and sustainable water management in North African countries. The main project’s results are:

- a set of maps describing water security and WW reuse potential in Egypt, Morocco and Tunisia, produced thanks to an innovative application to North Africa of the AWDO 2016 water security framework;
- an in-depth analysis of the effects of water vulnerabilities on food security and socio-economic development in the 3 target MACs;
- a basin-scale water vulnerability framework for assessing the effectiveness of integrated water management strategies;
- a toolbox of technologies for WW treatment and efficient reuse in agriculture, tailored to the local conditions of 3 selected basins in the target MACs;
- 4 field pilot plants of integrated WW treatment and water reuse in agriculture, operated in the 3 selected basins for over 1 year and available for further technology validation in future projects;
- a technical booklet and a set of technical videos on the MADFORWATER technologies for WW treatment and efficient reuse in agriculture;
- two Decision Support Tools for the model-based development of sustainable water management strategies;
- a set of integrated strategies for WW treatment and agricultural water management, with associated economic instruments, targeted to the 3 selected MACs;
- policy recommendations for the effective implementation of the proposed water management solutions in the 3 target MACs;
- business plans to foster the market penetration in the target MACs of the MADFORWATER SMEs;
- strategies for the market expansion in the target countries of water and irrigation enterprises;
- a consistent set of capacity building activities and materials;
- a set of guidelines for the adaptation to other MENA countries of the MADFORWATER tools, technologies and water management strategies.

Most of these results are freely available to any stakeholder through the project website and the Zeonodo and AMS Acta repositories.

The expected MADFORWATER impact is graphically illustrated in Fig. 8. The project is expected to lead, 10 years after its conclusion, to the following impacts in the 3 target countries:

- consistent increase of WW treatment and treated WW reused for irrigation;
- relevant increase of land irrigated with efficient technologies suitable for WW reuse;
- strong water saving in agriculture;
- increase in agricultural production and food security;
- increased income and employment potential of the water treatment and agricultural sectors;
- decrease of the overall costs associated to water vulnerability.
Fig. 7 - The model-based Decision Support Tool for the production of water management strategies

**GENERAL INPUTS**

- **Water parameters**
  - Availability, quality, irrigation efficiency, for both freshwater and treated WW

- **Farm and crop parameters**
  - Farm characteristics
  - Water and fertiliser requirements
  - Crop production costs, and market prices

**MADFORWATER-specific INPUTS**

- Increased availability of treated WW
- Use of MADFORWATER irrigation technologies for efficient use of freshwater and treated WW
- Implementation of economic instruments for water management

**HYDRO-AGRO-ECONOMIC MODEL**

**OUTPUTS**

- Optimized crop patterns
- **Outputs on water**
  - Optimized mix of freshwater and treated WW
  - Water productivity (and yield)
  - Water marginal value
- **Socio-economic output**
  - Farm income
  - Labour required

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Fig. 7 - The model-based Decision Support Tool for the production of water management strategies
Fig. 9 - MADFORWATER consortium meeting in Tunis, September 2019

Fig. 6 - Pilot plant for the treatment and reuse of drainage canal water (Lake Manzala, Egypt)
Fig. 2 - Map of the potential for wastewater reuse, relative to Tunisia

Fig. 5 - Pilot plant for the treatment and reuse of textile wastewater (Nabeul, Tunisia)

**Pre-treatment:** Screening, sand removal and degreaser
Elimination of 80% to 90% of fat and floating matter

**Primary treatment (anaerobic basin):** decantation and digestion
50 to 60% reduction in TSS, COD and BOD5

**Secondary treatment:**

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Infiltration percolation on sand massif
Reduction from 97% to 99% of TSS, COD and BOD5

Tertiary treatment: U.V rays
Total elimination of helmintheggs and fecal coliforms

Fig. 1 - The MADFORWATER concept

Fig. 4 - Pilot plant for the treatment and reuse of municipal wastewater (Agadir, Morocco)
Fig. 3 - Pilot plant for the treatment and reuse of municipal wastewater (Ariana, Tunisia)

**WW treatment technologies**

**IRRIGATION QUALITY TREATED WW**
- Increased turnover for WW treatment companies

**Other uses**

**Scenario 2**
- Reduced cost associated to water over-exploitation

**LAND IRRIGATED WATER QUALITY TREATED**
- Increase of WW reuse in agriculture

**Increase of availability**
- to decrease of groundwater catchment
Fig. 8 - The MADFORWATER impact

Dernière mise à jour: 11 Juin 2021
Numéro d’enregistrement: 226931