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MENAWARA

# WP3. ACTIONS TO INCREASE THE QUALITY OF NON CONVENTIONAL WATER USED IN AGRICULTURE

## Output 3.1. Non-conventional water quality indicators

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# INDEX



## LIST OF TABLES



## LIST OF FIGURES

# 1. SCOPE AND OBJECTIVES

The globally water scarcity, particularly important in arid and semi-arid regions such as Mediterranean area, is driving for a high competition for water resources. This creates the need for using so-called 'non-conventional sources' for water, such as low-yielding wells and springs, rainwater, urban runoff, stormwater and greywater, among others. In this frame, water reuse, with guarantees for public health and the environment, has ceased to be a marginal resource to become one of the basic strategies for water resources management and a key asset of any 'circular economy', not just in view of water availability but also nutrient and energy recovery.

Water reclamation and reuse have become an attractive option for conserving and extending available water supply and is a measure towards fulfilling following three fundamental objectives within a perspective of integrated water resources management:

- Environmental sustainability by reducing pollutants load and their discharge into receiving water bodies, and the improvement of the quantitative and qualitative status of those water bodies (surface water, groundwater and coastal waters) and the soils.
- Economic efficiency alleviating scarcity by promoting water efficiency, improving conservation, reducing wastage and balancing long term water demand and water supply.
- For some countries, contribution to food security growing more food and reducing the need for chemical fertilizers through treated wastewater reuse.

Water is reused worldwide, including the Mediterranean area, for various purposes. Globally, agricultural irrigation is the main application for water reuse with 32% of the reclaimed water used for this purpose. This is followed by landscape irrigation (20%) and industrial uses (19%). Recharge of groundwater is one of the least developed global uses with 2% of the reclaimed water being used for this purpose. However, this and various non-potable urban uses, recreational and indirect potable reuse are highlighted as an application with important potential. (EC, 2016, (ISO 16075-1, 2015). More specifically, Table 1 shows the main reclaimed water applications, worldwide.

Table 1. Main reclaimed water applications in the world, including Mediterranean area. (Adapted from NRMMC-EPHC-AHMC, 2006; EPA, 2012; Asano et al., 2006)

| Categories of uses | Uses |
|---|---|
| **Urban** | Irrigation of public parks, sporting facilities, private gardens, roadsides, street cleaning, fire protection systems, vehicle washing, toilet flushing, air conditioners, dust control, sewer flushing |
| **Agricultural** | Food crops not commercially processed, food crops commercially processed, pasture for milking animals, fodder, fibre, seed crops, ornamental flowers, orchards, hydroponic culture, aquaculture, greenhouses, viticulture |
| **Industrial** | Processing water, cooling water, recirculating cooling waters, washdown water, washing aggregate, making concrete, soil compaction, dust control |
| **Recreational** | Golf course irrigation, recreational impoundments with/without public access (e.g. fishing, bathing), aesthetic impoundments without public access, snowmaking |
| **Environmental** | Managed Aquifer Recharge, wetlands, marshes, stream augmentation, wildlife habitat, silviculture |
| **Potable** | Aquifer recharge for drinking water use, augmentation of surface drinking water supplies, treatment until drinking water quality |

In the frame of MENAWARA project, under WP3 (Actions to increase the quality of non-conventional water used in agriculture), Activity 3.1.1 (Field assessment of the efficiency of the Wastewater Treatment Plants (WWTP) and the quality of non-conventional water), the aim of the report 3.1 is to highlight the quality indicators for non-conventional water in the intervention areas.

Quality indicators have been identified based on National quality standards for water reuse in agriculture and assessed by the Consortium, mutually agreed with the Local Water Authorities of the intervention areas. Likewise, field assessments have been carried out in order to evaluate the technical situation of the 6 WWTPs in Tunisia, Palestine and Jordan, included in the frame of the project, those will allow to determine minor interventions and/or pre-post treatments to obtain quality treated wastewater suitable for the irrigation purposes.

# 2. WP3. ACTIONS TO INCREASE THE QUALITY OF NON CONVENTIONAL WATER USED IN AGRICULTURE

WP3 aims to assess the efficiency of no. 6 WWTPs in the intervention areas of North Africa and Middle East (Kelibia, Korba, BorjTouil and Choutrana-Tunisia, Ramtha-Jordan and Beit Dajan-Palestine) and to design, under the approach "fit to purpose", implement and test new low-cost pre and post-treatment systems to improve the quality of treated wastewater (TWW) for agricultural purposes. Target areas were chosen due to communities' favorable acceptance to use TWW whose use is so far limited due to its low quality and WWTPs inefficiency. Compared to all target areas, in Tunisia 4 sites will be considered due to the high interest of authorities/farmers to use better quality TWW.

Regarding European Countries, in Spain (Experimental Plant of Carrión de los Céspedes) a low-cost treatment train will be assessed for olive trees irrigation while an improved drainage water will be used to increase groundwater availability for irrigation purposes in Italy, by implementing MAR systems through Forested Infiltration Areas (FIA)

Figure 1. Intervention sites in MENAWARA project: (4) Tunisia, (1) Palestine, (1) Jordan, (1) Spain, (1) Italy

## 2.1. NON-CONVENTIONAL WATER QUALITY INDICATORS

The aim of the Output 3.1. is to identify the water quality indicators (both physic-chemical as microbiological) for the use of non-conventional water (treated wastewater) for agricultural reuse, according to the existing National standard of quality in the countries joining in MENAWARA project (Tunisia, Palestine, Jordan, Italy and Spain), as well as carry out a benchmarking between the 6 National standards; considering that the specifications of each one answer to the need and reality of each area.

### 2.1.1. NATIONAL STANDARDS FOR WATER REUSE IN TARGET COUNTRIES (JORDAN)

#### *JORDAN*

In Jordan, complete sets of regulations, standards and policies have been issued and enforced to regulate the utilization of treated wastewater and to minimize the public health risks and environmental pollution that may be associated with its reuse. This includes the reclaimed domestic wastewater standard JS 893/2006, Water Substitution and Reuse Policy, Water Reallocation Policy and Decentralized Wastewater Management Policy. All of the mentioned policies were issued as a complement to the National Water Strategy 2016–2025, which emphasizes the need to deal with treated wastewater as a component within an integrated water-resource-management framework.

The Jordanian standards for reclaimed domestic wastewater JS 893/2006 is the current version of the Jordanian standard dealing with reclaimed domestic wastewater (earliest versions are JS 893/1995 and JS 893/2002). This standard is based mainly on the guidelines of the WHO and FAO. It specifies the conditions that the effluent quality from wastewater treatment plants should meet in order to be discharged into streams, wadis or water bodies or to be used for artificial recharge of groundwater aquifers and to be used for irrigation purposes.

Regarding the agricultural irrigation purposes in JS 893/2006, there are four categories termed A, B, C, and D, referred to:

- Category A: irrigation of vegetables that are normally eaten cooked.
- Category B: irrigation of fruit trees.
- Category C: irrigation of industrial crops, field crops, and forest trees.

- Category D: irrigation of cut flowers

For the irrigation purposes, the reclaimed wastewater in Jordan is reused directly (i.e., without mixing with fresh water) and indirectly (i.e., after mixing with freshwater). The indirect reuse is practiced for unrestricted irrigation, which allows irrigation of crops likely to be eaten uncooked. On the other hand, the direct reuse is practiced for restricted irrigation which is limited to irrigating the crops that are mentioned in JS 893/2006 standard and categorized as A, B, C, and D. The direct reuse of the reclaimed water for irrigation of crops eaten raw such as cucumber, tomato, and lettuce is prohibited under the JS 893/2006. For unrestricted irrigation, the effluent is firstly diluted in reservoirs and/or mixed with fresh water to increase its quality before being used in irrigation.

Allowable limit for properties and criteria for reuse in irrigation according to the Jordanian Standard for Reclaimed Wastewater Use in Irrigation (JS893-2006) are shown in the following Table 2.

Table 2. Allowable limit for properties and criteria for reuse in agricultural irrigation (Adapted from JS893-2006)

| **Criterion** | **Allowable limit per end use** | | | |
|---|---|---|---|---|
| | **Field crop Industrial crop and forest tree** | **Fruit trees** | **Cooked vegetable** | **Cut flowers** |
| $BOD_5$ (mg/L) | 300 | 200 | 30 | 15 |
| COD (mg/L) | 500 | 500 | 100 | 50 |
| DO (mg/L) | - | - | <2 | <2 |
| pH | 6-9 | 6-9 | 6-9 | 6-9 |
| Turbidity (NTU) | - | - | 10 | 5 |
| $NO_3$-N (mg/L) | 70 | 45 | 30 | 45 |
| TSS (mg/L) | 300 | 200 | 50 | 15 |
| TN (mg/L) | 100 | 70 | 45 | 70 |
| E. coli (MPN) | - | 1000 | 1000 | > 1.1 |
| Intestinal helminthes (egg/L) | < or = 1 | < or = 1 | < or = 1 | < or = 1 |
| Fat, Oil and Grease (mg/L) | 8 | 8 | 8 | 2 |
| **Criterion** | **Allowable limit per end use** | | | |
| | **Cooked vegetable, fruit trees, field crop and Industrial crop and forest trees** | | | **Cut flowers** |

| | | |
|---|---|---|
| Phenol (mg/L) | <0.002 | 0.002< |
| MBAS | 100 | 15 |
| TDS (mg/L) | 1500 | 1500 |
| P-$PO_4$ (mg/L) | 30 | 30 |
| Cl (mg/L) | 400 | 400 |
| $SO_4$ (mg/L) | 500 | 500 |
| $HCO_3$ (mg/L) | 400 | 400 |
| Na (mg/L) | 230 | 230 |
| Mg (mg/L) | 100 | 100 |
| Ca (mg/L) | 230 | 230 |
| SAR | 9 | 9 |
| Al (mg/L) | 5 | 5 |
| As (mg/L) | 0,1 | 0,1 |
| Be (mg/L) | 0,1 | 0,1 |
| Cu (mg/L) | 0,2 | 0,2 |
| F (mg/L) | 2 | 2 |
| Fe (mg/L) | 5 | 5 |
| Li (mg/L) | 2.5 | 0.075 |
| Mn (mg/L) | 0.2 | 0.2 |
| Mo (mg/L) | 0.01 | 0.01 |
| Ni (mg/L) | 0.2 | 0.2 |
| Pb (mg/L) | 0.2 | 0.2 |
| Se (mg/L) | 0.05 | 0.05 |
| Cd (mg/L) | 0.01 | 0.01 |
| Zn (mg/L) | 5 | 5 |
| Cr (mg/L) | 0.1 | 0.1 |
| Hg (mg/L) | 0.002 | 0.002 |
| V (mg/L) | 0.1 | 0.1 |
| Co (mg/L) | 0.05 | 0.05 |
| B (mg/L) | 1 | 1 |
| CN (mg/L) | 0.1 | 0.1 |

Regarding to the irrigation techniques according to the Jordanian Standard for Reclaimed Wastewater Use in Irrigation (JS893-2006),

- It is allowable to use the drip irrigation
- It is prohibited to use flood (furrow) irrigation
- It is prohibited to use sprinkler irrigation except for irrigating golf courses and in that case irrigation should be practiced at night.

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