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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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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 (TUNISIA, PALESTINE AND JORDAN)

TUNISIA

The Tunisian standard for the discharge of wastewater to the receiving environment (NT 106.02, 1989 , approved in March 2018 by Order of the Minister of Local Affairs and the Environment and the Minister of Industry and Small and Medium-Sized Enterprises) is divided into three domains: maritime public domain, hydraulic public domain and public sanitation network. The purpose of this standard is to define the conditions for the effluents discharge subject to authorisation in the water environment (Decree No 85-56 of 2 January 1985) and characteristics for the dischargeof effluents into the public sanitation network (Decree No. 79-768 of 8 September 1979).

The quality of treated wastewater must comply, according the receiving environment, with the values established for the following parameters (Annex I Table c, Order 2018): TSS, BOD, COD, nitrates, nitrates, Kjeldahl nitrogen, total phosphorus, as well as microbiological (Fecal coliforms, Fecal streptococci, *Salmonella*, Choleric Vibrions and intestinal Nematode eggs), trace elements (Total Cr, Cr VI, Ni, CD, Pb; Fe; Zn; Cu, Hg), oils and grasses and some organic micropollutants (Hydrocabons, pesticides, PCB/PCT, and phenols). Irrigation with recycled wastewater is well established in Tunisia. The Tunisian government is pursuing wastewater reuse in agriculture as a strategic objective and is translating the objective into systematic practice. A wastewater reuse policy was launched at the beginning of the eighties.

Additionally, the use of treated wastewater in agriculture is regulated by the 1975 Water Code (law No. 75-16 of 31 March 1975), by the 1989 Decree No. 89-1047 (28 July 1989), by the Tunisian standard for the use of treated wastewater in agriculture (NT 106- 003 of 18 May 1989), by the list of crops than can be irrigated with treated wastewater (Decision of the Minister of Agriculture of 21 June 1994) and by the list of requirements for agricultural wastewater reuse projects (Decision of 28 September 1995).

They prohibit the irrigation of vegetables that might be consumed raw. Therefore, most of the treated wastewater is used to irrigate a list of crops, included in the Decree of June 21, 1994 of the Ministry of Agriculture:

- industrial crops including cotton, tobacco, sugar beet, flax, jojoba, castor, and safflower;
- cereal crops including wheat, barley, triticale and oats;
- fodder crops including alfalfa, corn, forage sorghum, etc;
- fruit trees including date palms, citrus fruits, olives, peaches, pears, apples, pomegranates, etc., and vines provided they are not irrigated by sprinkling;
- fodder shrubs including acacia and atriplex;
- forest trees;
- floral plants for drying or for industrial use including rose, iris, jasmine, marjoram and rosemary.

In 1989, a Decree was formulated and contained the conditions of reuse in agriculture under the Tunisian standard for agricultural reuse, NT 106.03 (1989), currently under review. The aim of the standard is to set the maximum allowable concentration for certain physical-chemical and microbiological elements in treated wastewater for agricultural irrigation.

The Tunisian standard NT 106.03 of June 1989 relating to the use of treated wastewater for agricultural purposes was developed on the basis of the recommendations of the FAO and WHO. The physicochemical and microbiological specifications are mentioned in Table 2.

Table 2. Tunisian Standards (NT 106-03) for reuse of treated wastewater in agricultural irrigation

Parameter	Unit	Tunisian Norme 106-03
pH		6,5≤ pH≤ 8,5
Conductivity	µS/cm	7000
COD	mg O_2/L	90
BOD5	mg O_2/L	30
Decantable materials	ml/L	-
TSS	mg/L	30
Chlorides	mg/L	2000
Active chlorine Cl_2	mg/L	-
Chlorine dioxide ClO_2	mg/L	-
Sulfate SO_4	mg/L	-
Mg	mg/L	-
K	mg/L	-
Ca	mg/L	-
Al	mg/L	-
S	mg/L	-
F	mg/L	3
NO_3	mg/L	-
NO_2	mg/L	-
Organic and ammoniacal nitrogen	mg/L	-
Total P, P-PO_4	mg/L	-
Phenols, phenolic compounds	mg/L	-
Saponifiable grease and oils	mg/L	-
Total aliphatic hydrocarbons (oils, fats and tar) of mineral origin	mg/L	-
Chlorine solvents	mg/L	-
Anionic detergents of the alkyl benzene sulfate (ABS) type	mg/L	-
Organochlorine	mg/L	0.001
As	mg/L	0.1
B	mg/L	3
Cd	mg/L	0.01
Co	mg/L	0.1
Br_2	mg/L	-
Ba	mg/L	-
Ag	mg/L	-
Be	mg/L	-
Cyanide CN	mg/L	-
Total chromium (Cr)	mg/L	0.1
Chrome Hexavalent CrVI	mg/L	-
Trivalent chrome CR III	mg/L	-
Sb	mg/L	-
Cu	mg/L	0.5
Fe	mg/L	5
Mn	mg/L	0.5
Hg	mg/L	0.001

Ni	mg/L	0.2
Pb	mg/L	1
Se	mg/L	0.05
Zn	mg/L	5
Mo	mg/L	-
Sn	mg/L	-
F	mg/L	-
Ti	mg/L	-
Pesticides and similar products: - Insecticides, Organophosphorus Carbonate Compounds - Herbicides - Fungicides - PCB and PCT	mg/L	-
Fecal coliforms	/ 100 mL	Absence
Arithmetic mean of intestinal nematode eggs	/ 100 mL	≤1/1000 mL

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