State-of-the-art of national regulations and strategies in Mediterranean countries in the field of water reuse

August 2024

AUTHORS

ECOFILAE Reuse Water

REVIEWER

Plan Bleu

LEGAL NOTICE

Table of contents

Table of illustrations

FIGURES

TABLES

Acronyms and abbreviations

	Definition
BOD	Biological Oxygen Demand
EU	European Union
IWMI	International Water Management Institute
MED	MEDiterranean
PE	Population Equivalent
TSS	Total Suspended Solids
TWW	Treated WasteWater
UN	United Nations
WHO	World Health Organisation
WWTP	WasteWater Treatment Plant

I. Context and scope

A. WATER REUSE CONTEXT IN THE MEDITERRANEAN AREA

The Mediterranean (MED) basin is facing important challenges: water availability is a recurring problem and almost 180 million people in the southern and eastern MED countries suffer from water scarcity, raising the possibility of conflict. Meanwhile even more frequent and more severe water scarcity and drought events are expected due to climate change and increasing population. By 2030 to 2050, the number of people classified as "water poor", (those living in countries under strong water stress[1]), will increase to 250 million.[2]

The Mediterranean Strategy for Sustainable Development (MSSD 2016-2025) is an integrative political and institutional document to support the development of national environmental and development policies in line with the Agenda 2023 and the sustainable development goals.

Several topics and strategic directions structure the Strategy. Some of them are dealing with water management and withdrawal. The Strategy also suggests adopting policies, regulatory measures and instruments for sustainable exploitation of non-renewable resources and related post-extraction restoration.

So, the strategic direction 2.1 of the MSSD encourages to promote the sustainable use, management and conservation of natural resources (including water) and ecosystems; when the strategic direction Strategic direction 4.1encourages to increase scientific knowledge, raise awareness, and develop technical capacities to deal with climate change and ensure informed decision-making at all levels, recognising and protecting the climate adaptation and mitigation services of natural ecosystems (including water monitoring system).

Water stress is constantly increasing in most of the Mediterranean countries (Figure 1). The range of the water stress in the Mediterranean countries is wide: from 10% (even less) in the Balkans to 100% and more in the Southern countries. In Libya, the water stress is over 817% (more than 8 times the available resources). Similar to SDG Indicator 6.4.2.

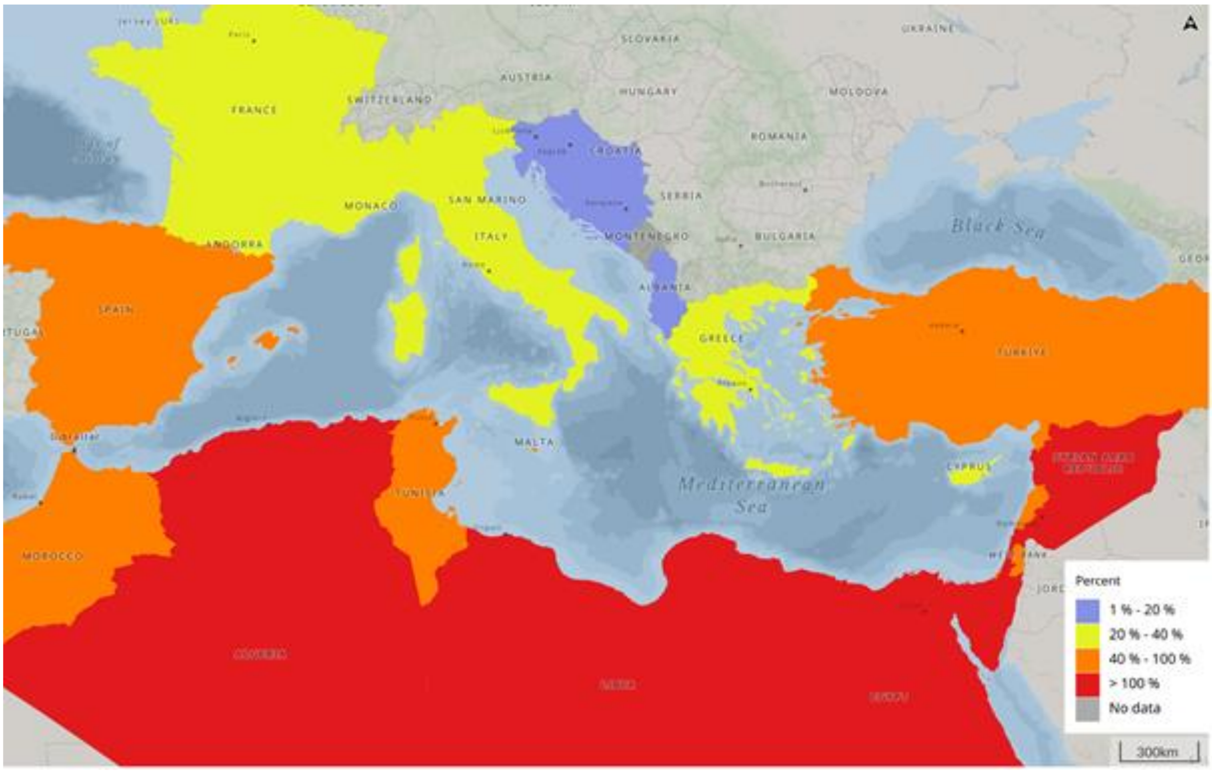
As a result, state water planners are **searching for solutions**, among which includes water reuse. Water reuse consists of using wastewater that has undergone different levels of treatment for beneficial purposes.[3]

[1] https://www.wri.org/data/water-stress-country

[2] MedECC, Wolfgang Cramer, Joël Guiot, Katarzyna Marini.et al, J Climate and Environmental Change in the Mediterranean Basin – Current Situation and Risks for the Future. First Mediterranean Assessment Report. November 2020.

[3] Plan Bleu n°11, 2012

Figure 1. Freshwater withdrawal as a proportion of available freshwater resources (in 2019)



Source: FAO, Aquastat. From MapX, Plan Bleu/RAC's Observatory

The **reuse of reclaimed water** (treated wastewater) can provide significant benefits, such as reducing water abstraction and offering alternative water resources, but also mitigating risks of hazardous effluent discharge. Nevertheless, each water reuse project should be subject to cost-benefit-risk and environmental analysis to ensure sustainability. This is especially true regarding the water footprint of a project, that could either be positive or negative according to the local context.

In the Mediterranean, the predominant planned use of reclaimed water is for direct and indirect **agricultural irrigation**. But some other practices are increasing, especially those substituting uses currently supplied by potable water in urban and peri-urban areas.

In European Union (EU) countries, water reuse for agricultural irrigation is increasingly being promoted thanks to the EU 2020/741 regulation released in 2020, while in the Mediterranean area some countries, such as Tunisia and Spain, have already been implementing water reuse schemes for decades.

Water reuse practices have increased in recent years and thus legislative frameworks are shifting as well in many countries. Considering the disparity in regulation frameworks and the lack of a general overview, PLAN BLEU has decided to establish a **state-of-the-art regulations and national strategies in the Mediterranean area.**

B. ILLUSTRATION OF WATER REUSE SCHEMES

To illustrate water reuse practices, descriptions of 3 operating water reuse schemes are detailed in Section 4.2:

- **Korba, Tunisia:** groundwater recharge
- **El Prat de Llobregat, Spain** : multiple uses
- **Anza, Palestine**: agricultural irrigation

C. SCOPE OF THE STUDY AND METHODOLOGY

The scope of the study is to describe the current state-of-the-art of water reuse regulations and strategies in the Mediterranean basin. It targets **planned water reuse practices**. Planned water reuse is the direct or indirect reuse of

reclaimed water (= treated wastewater fit for purpose), ensuring its conveyance through specially designed facilities and systems for treatment, storage, and distribution.[4]

The study focuses on:

- **Countries with a coastline** on the Mediterranean Sea that are the contracting parties of the Barcelona Convention - UNEP/MAP (21 countries – See Table 1)
- Treated urban wastewater (containing a high percentage of domestic wastewater) using centralised collection and treatment systems: **urban wastewater treatment plants (WWTP)**. Industrial WWTP dedicated to industrial wastewater treatment are not included.
- **Different water uses** listed below in Table 1.

Data collection and analysis was carried out in two distinct ways simultaneously:

- **Field data from national reference experts** in the different countries (interviews). The national reference stakeholders interviewed are presented in Annexe 1.
- **Bibliographic review and analysis** of national regulatory texts and of any relevant public documentation from reliable and identified sources.

Uncontrolled and unplanned water reuse practices are still common in the MED area, especially the reuse of untreated or low-level-treated wastewater. These practices are not targeted in this study. Historically, these practices enable the valorisation of nutrients in wastewater for their fertilizing potential, but they remain responsible for numerous negative health impacts. The UN, WHO and IWMI have worked for decades with those who use these practices to identify and to implement field solutions to control health and environmental impacts.

It is important to note that having effective and reliable wastewater collection and treatment systems is a prerequisite for deploying planned water reclamation and reuse solutions.

The main results of the study are presented first as a summary in Section 2. Then, the results are detailed and analysed by water use (Section 3) and by geographical region (Section 4). Finally, a focus on the main control procedures and regulatory constraints is presented (Section 5).

[4] Plan Bleu n°11, 2012; Asano et al., 2007

II. Summary of the results

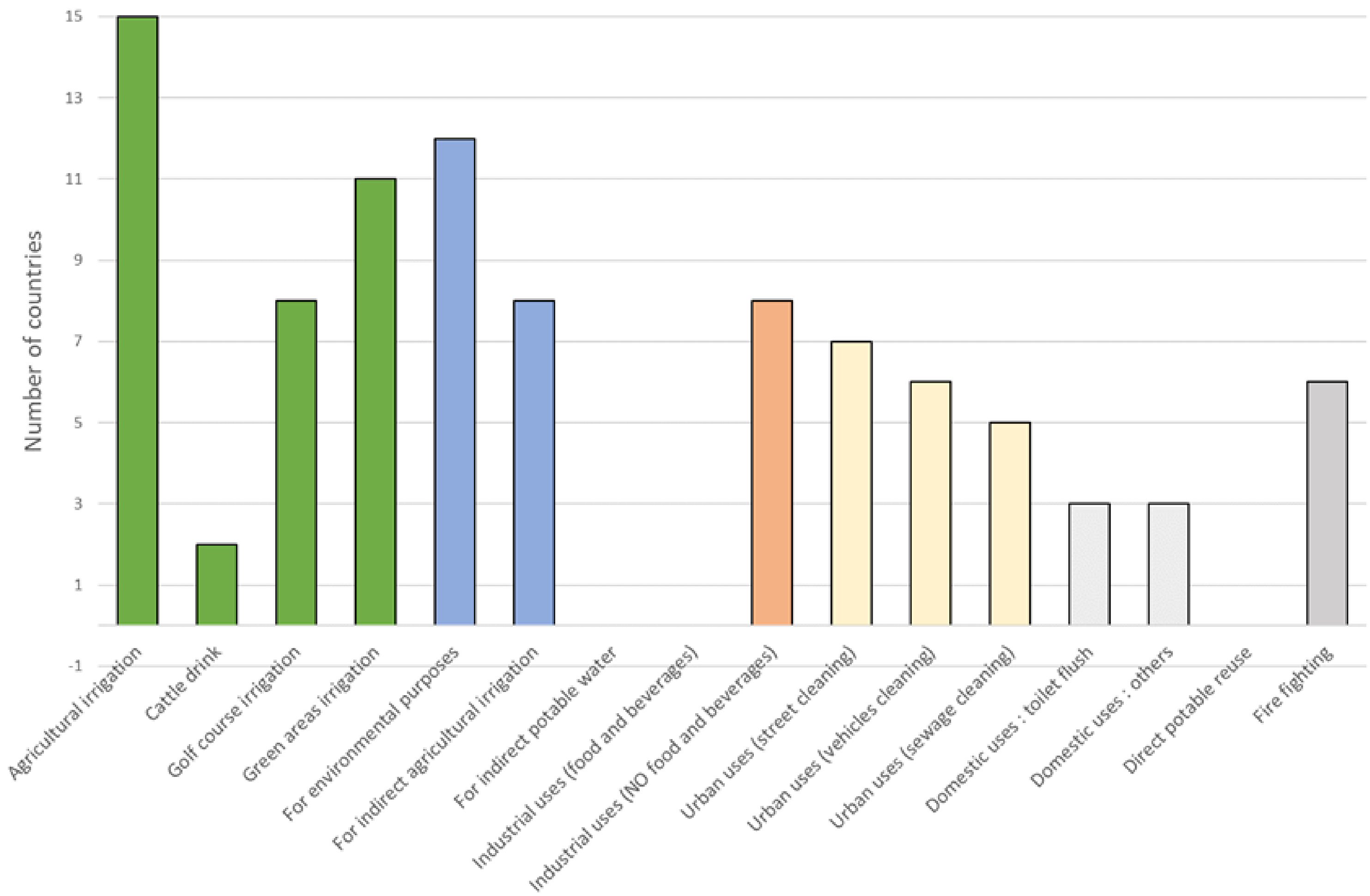
The main summary results are presented below in Table 1 and in Figure 2.

Table 1. State-of-the-art water reuse regulations in the MED area

Category of use	Reuse of Reclaimed water from urban wastewater treatment plant	European Union	Spain	France	Italy	Slovenia	Croatia	Bosnia Herze.	Montenegro	Albania	Greece	Türkiye	Syria	Lebanon	Cyprus	Malta	Palestine	Israel	Egypt	Libya	Algeria	Tunisia	Morocco
Irrigation	Agricultural irrigation	Authorised	Authorised	Authorised	Authorised	Authorised	Authorised	Not regulated	No data	No data	Authorised	Authorised	No data	No data	Authorised	Authorised	Authorised	Authorised	Authorised	Not regulated	Authorised	Authorised	Authorised
	Cattle drink	Not regulated	Not regulated	Not regulated	Authorised	Not regulated	Not regulated	Not regulated	No data	No data	Not regulated	Authorised	No data	No data	Not regulated	Not regulated	Unauthorised	No data	No data	Not regulated	No data	Not regulated	Unauthorised
	Golf course irrigation	Not regulated	Authorised	Authorised	Authorised	Not regulated	Not regulated	Not regulated	No data	No data	Authorised	Authorised	No data	No data	Authorised	Not regulated	Not regulated	No data	No data	Not regulated	No data	Authorised	Authorised
	Green areas irrigation	Not regulated	Authorised	Authorised	Authorised	Not regulated	Not regulated	Not regulated	No data	No data	Authorised	Authorised	No data	No data	Authorised	Not regulated	Not regulated	Authorised	Authorised	Not regulated	Authorised	Authorised	Authorised
Groundwater and surface recharge	For environmental purposes	Authorised	Authorised	Authorised	Authorised	Authorised	Authorised	Not regulated	No data	No data	Authorised	Authorised	No data	No data	Authorised	Not regulated	Unauthorised	Authorised	Authorised	Not regulated	Authorised	Authorised	Authorised
	For indirect agricultural irrigation	Not regulated	Not regulated	Not regulated	Not regulated	Not regulated	Not regulated	Not regulated	No data	No data	Not regulated	Not regulated	No data	No data	Not regulated	Not regulated	Unauthorised	Not regulated	Not regulated	Not regulated	Not regulated	Not regulated	Not regulated
	For indirect potable water	Not regulated	Unauthorised	Not regulated	Unauthorised	Not regulated	Not regulated	Not regulated	No data	No data	Not regulated	Not regulated	No data	No data	Not regulated	Not regulated	Unauthorised	No data	No data	Not regulated	No data	Not regulated	Unauthorised
Industrial uses	Industrial uses (food and beverages)	Not regulated	Unauthorised	Unauthorised	Unauthorised	Not regulated	Not regulated	Not regulated	No data	No data	Not regulated	Not regulated	No data	No data	No data	Not regulated	Unauthorised	Unauthorised	No data	Not regulated	No data	Not regulated	Unauthorised
	Industrial uses (NO food and beverages)	Not regulated	Authorised	Authorised	Authorised	Not regulated	Not regulated	Not regulated	No data	No data	Authorised	Authorised	No data	No data	No data	Not regulated	No data	Authorised	No data	Not regulated	Authorised	Not regulated	Authorised
Urban uses	Urban uses (street cleaning)	Not regulated	Authorised	Authorised	Authorised	Not regulated	Not regulated	Not regulated	No data	No data	Authorised	Authorised	No data	No data	Not regulated	Not regulated	Not regulated	Authorised	No data	Not regulated	No data	Not regulated	Authorised
	Urban uses (vehicles cleaning)	Not regulated	Authorised	Authorised	Authorised	Not regulated	Not regulated	Not regulated	No data	No data	No data	Authorised	No data	No data	Not regulated	Not regulated	Not regulated	Authorised	No data	Not regulated	No data	Not regulated	Authorised
	Urban uses (sewage cleaning)	Not regulated	Not regulated	Authorised	Authorised	Not regulated	Not regulated	Not regulated	No data	No data	No data	Authorised	No data	No data	Not regulated	Not regulated	Not regulated	Authorised	No data	Not regulated	No data	Not regulated	Authorised
Domestic uses	Domestic uses : toilet flush	Not regulated	Not regulated	Unauthorised	Authorised	Not regulated	Not regulated	Not regulated	No data	No data	Not regulated	Not regulated	No data	No data	Not regulated	Not regulated	Not regulated	Authorised	No data	Not regulated	No data	Not regulated	Authorised
	Domestic uses : others	Not regulated	Not regulated	Unauthorised	Authorised	Not regulated	Not regulated	Not regulated	No data	No data	Not regulated	Not regulated	No data	No data	Not regulated	Not regulated	Not regulated	Authorised	No data	Not regulated	No data	Not regulated	Authorised
Other category	Direct potable reuse	Not regulated	Unauthorised	Unauthorised	Unauthorised	Not regulated	Not regulated	Not regulated	No data	No data	Not regulated	Not regulated	No data	No data	Not regulated	Not regulated	Unauthorised	No data	No data	Not regulated	No data	Not regulated	Unauthorised
	Fire fighting	Not regulated	Not regulated	Authorised	Authorised	Not regulated	Not regulated	Not regulated	No data	No data	Authorised	Authorised	No data	No data	Not regulated	Not regulated	Not regulated	Authorised	No data	Not regulated	No data	Not regulated	Authorised

Couleur	Lib
(green)	Authorised by regulation
(red)	Unauthorised by regulation
(grey)	Not regulated
(light yellow)	No data

Figure 2. Number of MED countries (out of 21) with regulatory authorization for each water use



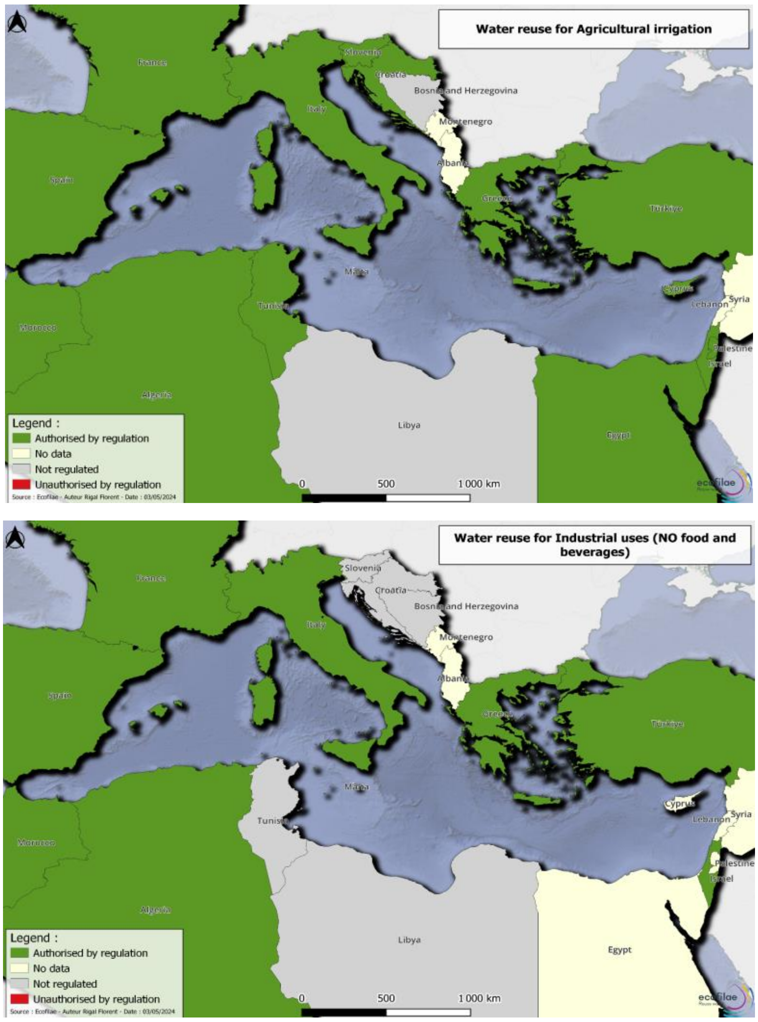
III. Analysis by water use

Agricultural irrigation is the most widespread practice for water reuse in the Mediterranean area: it also stands out as the most legislated use, as shown in Figure 2, with 15 out of 21 Mediterranean countries having a specific legislative framework.

Those regulatory texts often contain restrictions, precautions, and barriers to control sanitary risks, such as imposing **different levels/thresholds of water quality for different crop types and for different irrigation methods** (e.g., EU, Türkiye, Algeria, Egypt, Morocco, etc.). Before the publication of the EU regulation in 2020, Cyprus' national regulation also had different thresholds according to the size of the WWTP.

A **multi-barrier approach** (e.g. in the EU and in French regulations) enables projects to deviate from one water quality threshold to another by implementing sanitary control measures, or barriers. One barrier can, for example, be the implementation of a specific irrigation practice ensuring no contact between the edible part of the plant and the irrigation water. In most MED regulations, special attention is given to the irrigation of crops consumed raw, where the edible part comes into direct contact with reclaimed water.

Figure 3. Current water reuse regulation in the Mediterranean region – Water reuse for agricultural irrigation and for industrial uses (no food and beverages)



The existing water reuse regulations often include **green space irrigation (including golf courses)** with 11 of the Mediterranean countries specifically mentioning this practice in their water reuse regulation framework. These practices are significantly increasing in tourist areas.

Other **urban uses,** such as for street and vehicle cleaning, or high water-pressure sewer cleaning, are also on the rise, as well as for firefighting. While they may require smaller volumes (between 2 000 to 10 000 m³ per year) compared to agricultural irrigation (can reach several million m³ per year), these urban uses often provide high added value as they **enable potable water savings**. Almost one third of Mediterranean countries (France, Spain, Italy, Croatia, Greece, Turkiye, Israel, Morocco) have specific references to urban cleaning in their regulation framework (see Table 1). Water quality requirements for urban uses, where they exist, are often high or aligned with the most stringent water quality requirements used for agricultural irrigation. This is because of the relatively high likelihood of exposure for operators and the public.

The **recharge of surface and groundwater bodies** with treated wastewater for indirect reuse can be authorized according to the type of use targeted. While **indirect water reuse for agricultural irrigation** is a common practice, such as in Egypt in the Nile River Delta, the recharge of groundwater can also be used to fight against salinization and desertification. As for **potable reuse** it is still forbidden in all Mediterranean countries. France has the first pilot demonstrator for indirect potable reuse whose results will likely be used as a benchmark.

There is also a growing interest to reuse reclaimed water for **industrial uses**. The practice seems driven by two primary motivations: cost optimization and water supply security during restrictions. Industrial processes and cleaning are the main uses targeted. Industries (often excluding the food and beverage industry) can be subject to stringent water restrictions, which can be extended to complete bans on drawing water from potable networks or from natural water bodies. This can lead to significant financial loss for industry. Thus, water reuse can be an attractive solution. The food and beverage industry is often prohibited from water reuse practices in the regulations due to the sanitary risks associated.

In countries where many uses are regulated, **identical water quality thresholds can be applied to different uses**. In practice, this facilitates the implementation of beneficial multi-use projects. For example, in Türkiye, the same thresholds are used for green space irrigation and for industrial purposes, while in Greece, the same thresholds are used for agricultural irrigation, for groundwater recharge, and for industrial purposes.

IV. Analysis by geographical region

A. REGIONAL TRENDS ON WATER REUSE

When water reuse is clearly identified as a solution and when the legislative and institutional frameworks are well-established then governments can define and publish national strategies about water reuse. **National strategies often contain quantified objectives,** such as a percentage or a volume of treated wastewater (TWW) to be reused, or a number of projects to be reached by 5, 10 or 20 years (e.g. in France). The strategies are also often accompanied by financial measures, such as grants or subsidies, making the implementation more attractive for both private and public sectors. In some countries, water reuse strategies come along with obligations: in Türkiye the 10th Article of the Water Pollution Control Law requires municipalities to study the feasibility and the profitability of water reuse within their territories.

The Table 2 below presents the **percentage (%) of TWW reused (range) per country** and their GDP per capita based on the literature. There seems to be no obvious correlation between the two information, and there isn't one either between the GDP and the number of uses regulated in each country (see Table 1).

Table 2. Synthesis of water reuse percentage per country (* EU members)

Countries	% of TWW reused (range)	GDP(€)/capita (2022)[5]
1-Spain*	[5-15]	29 350,20
2-France*	[0-5]	40 963,80
3-Italy*	[5-15]	34 158,00
4-Slovénia*	[0-5]	29 457,40
5-Croatia*	[0-5]	18 413,20
6-Bosnie -Herzegovina	[0-5]	7 585,40
7-Monténégro	[0-5]	9 893,50
8-Albania	[0-5]	6 802,80
9-Greece*	[0-5]	20 732,10
10-Türkiye	[0-5]	10 616,10
11-Syria	[0-5]	537,20[6]
12-Lebanon	[0-5]	4 136,10
13-Cyprus	[50-100]	31 283,50
14-Malta*	[0-5]	33 940,90
15-Palestine	[5-15]	3 598,00
16-Israel	[50-100]	54 659,80
17-Egypt	[15-50]	4 295,40
18-Libya	[0-5]	6 716,10
19-Algeria	[5-15]	4 273,90
20-Tunisia	[5-15]	3 776,70
21-Morocco	[5-15]	3 527,90

Climate and hydrological conditions seem to be the main drivers for water reuse development, both in terms of percentage of water reuse and in terms of regulation development. Nevertheless, countries with unstable economic and political situations (e.g. Syria, Lebanon and Lybia) have been unable to implement water reuse, or to formulate and enforce a regulation framework.

In 2020, **the EU** introduced a water reuse regulation for agricultural irrigation. It came into effect in all EU countries in 2023 and thus some EU countries need to adapt their national legislation to fit (Italy, France, etc.). In Malta, transcription of the EU regulation within national regulation has already been implemented. Prior to the 2020 EU regulation, some EU countries already had a national regulation covering multiple uses, such as in Spain where agricultural, green space, and golf course irrigation, as well as urban uses were integrated within one single decree. Cyprus' regulation was implemented in 2005 and covered agricultural irrigation, groundwater recharge and disposal into surface waters.

[5] https://donnees.banquemondiale.org/indicator/NY.GDP.PCAP.CD
[6] GDP/capita for the year 2020

The practice of water reuse appears to be very limited in the **Western Balkans countries** bordering the Mediterranean, and there are presently no water reuse regulations in these countries. **Türkiye,** however, has clear regulations covering multiple uses, including irrigation, industrial and urban uses.

In **Libya, Lebanon and Syria** there is no clear strategy, or regulation concerning water reuse, mainly due to the unstable economic and political context. However, some unsuccessful attempts have been made in the past (e.g., Libya). **Palestine** has developed a national legislative framework targeting agricultural irrigation, thus enabling the spread of this practice.

Israel is still a leader in terms of planning and development of water reuse practices with a legislative framework that authorizes several different uses.

Egypt's water reuse potential is very high. National legislation for direct use is quite restrictive, (agricultural irrigation is not authorized for vegetable crops eaten raw, regardless of the treated water quality), while the national strategy for water reuse is very ambitious and oriented toward indirect practices (a mix of water resources), especially in the Nile Delta area.

The Maghreb countries are very active on the topic of water reuse. Tunisia has developed water reuse schemes for decades, while Morocco has implemented an ambitious water reuse policy and regulation strategy thus leading to a fast-growing development of the practice.

B. FOCUS BY COUNTRY

The focus by country presented below was completed where information and data were available, sufficient, and able to be validated. Thus, not all MED countries are included (see Table 1 - 16/21).

1. European Union

The European Union has a regulation framework for the reuse of treated wastewater in **agricultural irrigation: the Regulation (EU) 2020/741 of May 25, 2020**, concerning "Minimum Requirements for Water Reuse." It was required to be enforced by member states from May 25, 2023. The text is directly binding on member countries.

The regulation defines **4 water quality classes** and specifies the types of crops applicable to each of them. There is a provision to use water of lower quality than initially prescribed by implementing barrier measures to ensure an equivalent sanitary risk. Thus, the implementation of this barrier mechanism allows for the "downgrading" of water quality. These barrier measures may, for example, take the form of different irrigation methods or restrictions on public access.

At the EU scale, there are no water reuse regulations yet for uses other than agricultural irrigation.

2. Spain

Spain transposed the **EU Regulation 2020/741** for agricultural irrigation into local law (Royal Decree-Law 4/2023, of May 11).

Spain is an EU pioneer in water reuse and has the highest water reuse rates in the EU (between 15 and 30% of treated wastewater reused each year). The former regulation is centralized in a single document, "**Real Decreto 1620/2007**". This regulation remains current for other uses such as urban cleaning.

CASE STUDY: El Prat de Llobregat, Spain: multiple uses

The Barcelona WWTP (Baix Llobregat – Activated sludge – 2 000 000 P.E. – 420 000 m^3/d) is one of the largest and most modern in Europe.

In 2006, different tertiary/reclamation treatment lines were installed to obtain **various water qualities fit for different uses**: including agricultural irrigation, industrial uses, urban uses (road cleaning, green areas, and hydrocuring), and also recharge of wetlands, of the Llobregat river (indirect reuse and environmental benefits), and a nearby aquifer (to limit saline intrusion).

Three different water qualities are produced with a total capacity of **300 000 m^3 per day.**

The salinity level of the treated wastewater is a major issue for its reuse: solutions such as electrodialysis, reverse osmosis and dilution with potable water are used.

Figure 4. El Prat del Llobregat WWTP, irrigated area, and Llobregat river

3. France

France transposed the **EU Regulation 2020/741** for agricultural irrigation into local law in the **FR Regulation 2023/12/18**.

The French regulation is currently undergoing evolution with several decrees expected to regulate numerous uses. Thus, France is building a holistic water reuse regulation approach through the "**Framework decree 2023-835 du 29/08/2023**". This decree defines permitted and prohibited uses and will be complemented by a decree for different uses, outlining the different quality classes to be adhered to, along with all regulatory provisions necessary for implementing a treated wastewater reuse project. Currently, decrees for green space and agricultural irrigation were published respectively December 14 and 18, 2023.

The government is strongly encouraging water reuse through policy declarations and setting quantified targets to be achieved by 2030: a water plan was released in the summer of 2023, outlining a goal to implement 1000 water reuse projects by 2030, and to reach 10% of the wastewater reused by 2030. Nevertheless, in 2024, France still reuses less than 1% of its total treated wastewater.

4. Italy

Italy is also experiencing regulatory changes and must transpose the **EU Regulation 2020/741** for agricultural irrigation into local law. The current regulation, **'Water Reuse Regulation (DM 185/2003)' dated 2003**, has proven to be a hindrance to implementing direct water reuse projects due to a very large number of routine physicochemical parameters to be monitored. Thus, indirect water reuse practices are predominant for agricultural irrigation. Other uses remain negligible in practice.

A new regulation document is currently available for public consultation and should be published soon: it aims to simplify project implementation and to integrate the EU regulation for agricultural irrigation. One single document would regulate all uses.

5. Slovenia

Slovenia is following the **EU Regulation 2020/741** for agricultural irrigation and has yet translate it into local law. Nonetheless, sanitation performance seems to be the national priority over water reuse.

6. Croatia

The regulatory texts governing water reuse are: **'Narodne novine**,**' number 153/09 from 2020, 'Narodne novine,' number 153/09 from 2010,** and **'Narodne novine,' number 46/07 from 2008**, but water reuse does not seem to be a common practice in Croatia.

The **Integrated Water Management Strategy** published by the government in 2008 make mention of water reuse for agricultural and industrial purposes, particularly as a means of limiting pollution to the natural environment. However, specific quantified objectives are not provided.

The priority does not seem to lean towards water reuse. Building wastewater treatment plants and ensuring the compliance with European standards appears to be the primary national concern.

7. Greece

Greece regulates and authorizes numerous uses through a single text, the **'Ministerial Decree 145116/11' from 2011.** The **EU Regulation 2020/741** for agricultural irrigation shall be transposed into local law.

Uses other than agricultural irrigation, such as urban uses, are aligned with the 2 water quality classes defined in the Decree 145116/11.

Like Italy, although the regulation seems quite permissive by allowing a significant number of uses, it is relatively restrictive as it requires the monitoring of many parameters (high analysis costs).

8. Türkiye

In Türkiye water reuse is governed by two regulatory texts: the **'Regulation on Water Pollution Control' from 2004** and the **'Wastewater Treatment Plants Technical Procedures Communique**' from 2010.

The Turkish water reuse framework allows for numerous uses, it defines water quality standards for each of them, and it specifies the treatments required.

The Ministry of Environment, Urbanization and Climate Change aims to increase the reuse rate of treated wastewater to 5% by 2023 and to 15% by 2030 (website of the Ministry). The Water Pollution Control Law mandates municipalities to study the feasibility and the profitability of water reuse for various purposes within their territories. The approximate current rate of treated wastewater reused stands between 1 and 4% (high uncertainty).

9. Cyprus

The Cypriot water reuse regulations are governed by two key texts: the "**Cyprus Sewerage Systems Law 108(I)/2004**" and the "**Cyprus National Implementation Program of the Directive 91/271/EEC**". The **EU Regulation 2020/741** for agricultural irrigation shall be transposed into local law. Cyprus has one of the largest percentages of water reuse worldwide, with an aim to increase this percentage to 100% of treated water reused.

Cyprus considers the size of the wastewater treatment plant (WWTP) in the definition of water quality classes for agricultural irrigation. Specifically, the water quality classes differ based on whether the plant receives a load lower or higher than 2 000 PE. For smaller plants, 4 classes may apply depending on the crops. For larger plants (over 2 000 PE), a single class applies to all uses. Cyprus utilises membrane bioreactors or conventional activated sludge coupled with chlorination or UV disinfection for the production of high-quality effluent.

The government's goal is **to reuse 100% of treated wastewater**, and thus, water reuse requirements are directly integrated into the municipal wastewater treatment regulations. Yet, the pathway to reach this goal are not fully established, but political willingness is the driving force here, suggesting a substantial investment in the sector and thus a keen interest among sanitation professionals in Cyprus.

10. Malta

The practice of water reuse in Malta is regulated through three texts: **'The Water Services Corporation Act,'** and **'Urban Wastewater Regulations, 2006,'.** Malta has already integrated the **EU Regulation 2020/741** for agricultural irrigation.

Water reuse practices seem to be increasing in Malta, but the high salinity of wastewater (intrusion of seawater in sewers in coastal areas) often restricts its reuse. This situation has required the development of high-end treatment systems based on membrane filtration to reduce the salinity of the reclaimed water and hence enable its effective reuse in agriculture.

The case of greywater is particularly relevant, as the country's legal code mandates the connection of all domestic wastewater to the sewer, making the reuse of greywater unfeasible. A regulatory assessment is currently being undertaken with a view of facilitating the use of greywater in the urban and industrial sectors.

11. Palestine

The Palestinian regulatory framework is governed by a single document titled "**Treated Wastewater Effluent for Agricultural Purposes.**" The Palestinian regulation focuses on irrigation, with agriculture being the sole authorized use.

Authorities have clearly identified water reuse as a significant opportunity to alleviate the substantial pressure on water resources. However, financing appears challenging despite financial support from numerous national and international organizations to several projects: North Gaza, Nablus west, Jenin, Jericho, Hebron, Tubas, Salfit and Al Auja… The development of the water reuse sector seems to be a challenge given the frequent overload experienced by WWTP in the Gaza Strip and the complex geopolitical context. Access to effective and reliable sanitation appears to be more of a priority to prevent the spread of waterborne diseases.

Palestine has defined a **National Plan for the Environment 2023-2035**. The objective n°3 targets water reuse.

CASE STUDY: Anza, Palestine: agricultural irrigation

Since 2015, **all the water from the Anza WWTP (120 m³/d) is reused** to irrigate olives trees, alfalfa, apricots, and luffa, as well as a 500 m² greenhouse with roses.

The activated sludge process is followed by a **chlorination step.**

Gravity is used to deliver irrigation water to the fields using a hydraulic network. Seven to 12 farmers can be supplied: water reuse covers 25% of the total demand.

After 5 years of operation the pumps, pipes, and drip irrigation systems needed consistent maintenance and replacement. Improved practices to prevent and manage clogging have now partially solved the issue.

Figure 5. Anza WWTP

12. Israel

Israel has one of the highest percentages of water reuse worldwide, with a constant drive to improve this percentage.

The Israeli water reuse regulatory framework is defined primarily by the following texts: "**Public Health Regulations for Effluent Quality and Sewage Treatment, 2010**", and the **rules governing the use of wastewater in urban areas, leisure, and industries from 2003.**

The Israeli water reuse regulation allows for numerous uses. It defines quality standards for each of them. It also specifies the level of treatment and the treatment technologies required to meet those standards. The Israeli water reuse regulation also considers the size of the wastewater treatment plant (WWTP) in the definition of water quality classes.

13. Egypt

The water reuse regulatory framework in Egypt is based on the following documents: "**Egyptian Code No. 501/2005** on the reuse of treated wastewater in the field of agriculture" and the "**Egyptian Code No. 204/2012** for using treated wastewater in agriculture".

Egypt is strongly reliant on irrigation for its agricultural sector, the Nile River being the main water source. Nearly half of the treated wastewater in Egypt is reused. The water reuse levels and rates in Egypt remain to be confirmed due to varying figures presented in the literature, showing significant discrepancies. This might be explained by a substantial portion of treated water being reused in an indirect way after mixing with Nile River water. This reuse can occur in a planned or unplanned manner.

A government strategy document titled "**2030 National Vision for Wastewater Re-use in Egypt**" outlines an investment of 287 million US dollars by 2030. The document also emphasizes diversification of uses beyond agriculture. Furthermore, this document specifies that the increasing strain on resources in Egypt serves as an incentive to broaden the regulatory scope of water reuse practices. Various uses are mentioned, such as groundwater recharge, dust control, and firefighting. A regulatory evolution in this regard might come into effect by 2030.

14. Libya

The water reuse regulatory landscape in Libya is currently lacking. Despite facing water scarcity issues, state institutions have not yet focused on managing or legislating the practice. There is no established national water strategy in Libya.

The Water and Wastewater Company primarily deals with supplying drinking water and operating treatment plants. Attempts were made in the past to reuse water for irrigation, but these projects ceased, due to the shutdown of most of the sewage treatment plants.

15. Algeria

Water reuse in Algeria is framed by following laws: Law No. 05-12 dated August 4, 2005, Decree No. 07-149 dated May 20, 2007, Interministerial Order of January 2, 2012, and Executive Decree No. 10-23.

In the field of water reuse Algeria stands out in two aspects:

- Firstly, **the bottom-up approach** adopted by the government to address grassroots actors. There is a strong demand from actors in the field that drives many to experiment without regulatory approval. The government responds by legislating to prevent deviations.
- Secondly, due to the high demand, the government has set **ambitious goals**. This is why a significant regulatory evolution can be expected to achieve these objectives.

Thus, Algeria has set **numerous objectives for water reuse**, including the irrigation of 4 800 hectares with an investment exceeding 6 billion Algerian dinars by the year 2024. Looking ahead to 2030, the goals include universalizing access to sanitation services, and harnessing treated wastewater for agricultural and industrial purposes within a suitable and incentivizing regulatory framework. Algeria aspires to achieve irrigation across 100 000 hectares using unconventional water resources, specifically treated wastewater and drainage water. There is also mention of expanding the regulatory framework with a focus on groundwater recharge.

16. Tunisia

The Tunisian water reuse regulatory framework is supported by several texts, including **Law No. 82-66 dated August 6, 1982**, the **Decree No. 93-2447 dated December 13, 1993** (which modifies the conditions for using treated wastewater in agriculture from Decree No. 89-1047 from July 28, 1989), the Minister of Agriculture's **Decree of June 21, 1994, Law No. 2001-116 from November 26, 2001** (modifying the Water Code), and the **Water Code 2017, Law No. 75-16**.

Tunisia is a pioneer country in the field of water reuse: its first planned scheme was implemented in 1968. However, it seems that current regulations are no longer tailored to current needs and to the advancements in scientific and technological knowledge. Furthermore, many facilities that have not been renovated seem to be largely outdated.

The **Water Strategy 2050** aims to enhance water reuse, with a target of 426 million m^3 reused, including 229 million m^3 allocated to agricultural irrigation. The Ministry of Water has conducted numerous strategic studies on water reuse, including the transfer of reclaimed water in “Grand Tunis”, a communication strategy on the valorisation of reclaimed water and sludge, and the promotion of water reuse for non-agricultural uses.

CASE STUDY: Korba, Tunisia: groundwater recharge

The main goal of the Korba groundwater recharge project is to compensate for the overexploitation, and thus **to avoid saline intrusion from the sea, to ensure water supply to farmers, and to preserve the environment** (water tables and natural lagoons in a coastal area).

The Korba WWTP process is an activated sludge system (75 000 PE) followed by maturation ponds. Reclaimed water is too salty to be reused directly for agricultural irrigation.

1,500 m^3 of reclaimed water are recharged every day (550 000 m^3 per year) through specific infiltration basins. Farmers (GDA) then withdraw water in the aquifer to irrigate around 8 500 Ha. The agricultural production is primarily intended for food consumption in Tunis (vegetables and fruits). The main stakeholders involved in the project are:

- The National Office for Sanitation (ONAS) oversees the treatment/reclamation.
- The Regional Office for Agriculture Development (ORDA) oversees the reinjection.
- The Agriculture Development Group (GDA) oversees the water withdrawals from the aquifer for farmers.

Figure 6. Korba WWTP (Google map)

17. Morocco

The **Morocco Law No. 36-15** concerning water reinforces the previous Law No. 10-95 and targets water reuse. Additionally, the **decree No. 1276-01 dated October 17th, 2002,** sets the standards for water quality intended for irrigation. Morocco has a relatively strong regulatory and institutional framework concerning water reuse. Indeed, a wide range of uses are regulated and permitted. Four quality classes are set for agricultural irrigation: they serve as benchmarks for other uses.

There are numerous political and financial incentives to increase water reuse and to meet the on-the-ground needs. However, it seems that more new projects are emerging for agricultural irrigation compared to other uses related to green spaces, golf course irrigation, or industrial applications.

The Priority Program for Drinking Water Supply and Irrigation 2020-2027, with Axis 2 dedicated to water reuse, outlines a plan for 87 projects (including 85 in agriculture) by 2027.

The **National Water Strategy (SNE) 2010-2030**, under its "Improvement of Supply" axis, advocates for the utilization of unconventional water resources, particularly seawater desalination (400 million cubic meters per year) and the **reuse of treated wastewater (300 million cubic meters per year)**. This is intended for "*golf course and green space irrigation, as well as the irrigation of suitable crops and artificial recharge of aquifers*". A National Program for the Reuse of Treated Wastewater has been in place since 2015.

V. Main control procedures and regulatory constraints

A. WATER QUALITY CLASSES AND THRESHOLDS

Water reuse regulations always include **water quality thresholds, and very often define quality classes**. Classes are associated with one or several uses, and they are characterized by different water quality parameters and their associated thresholds. Some countries have a unique water quality class for numerous uses, while some countries have multiple classes: one for each use.

The water quality thresholds and the parameters associated mainly target **health risks** (pathogens, virus, bacteria, parasites…), and to a lesser extent environmental impacts. Salinity is rarely targeted by official water reuse thresholds.

Agricultural irrigation often includes several water quality classes, which differ in the **type of crops and in the irrigation methods** (up to 4 water quality classes in the EU regulation). Water quality requirements for other uses such as urban uses, when they exist, are often aligned with the most stringent water quality class used for agriculture.

In some countries, like Cyprus and Türkiye (and Israel to some extent), water quality **classes are defined along with the type of treatment required** to achieve them. The WHO guidelines for municipal wastewater reuse[7] also suggest treatment technologies for each use to achieve the required water quality.

In Table 3, a country comparison of classes and thresholds for water reuse in agricultural irrigation is presented (when data is available and checked). It also includes the WHO recommendations (WHO, 2006). For better clarity, Table 3 focuses on several "recurrent" physicochemical and microbiological parameters (E. coli, BOD and TSS). Nonetheless, the number of parameters with thresholds within each national regulation is detailed.

[7] WHO Guidelines for the safe use of wastewater, excreta and greywater, 2006

Table 3. Country comparison of classes and thresholds for water reuse in agricultural irrigation

	Classes	E. coli (UFC/100 mL)	BOD (mg/L)	TSS (mg/L)	Nb of microbiology parameters	Nb of physicochemical parameters	Uses	Irrigation method
European Union (Spain, France, Italy, Slovenia, Croatia, Greece, Cyprus and Malta)	Class A	10	10	10	5	3	All food crops consumed raw where the edible part is in direct contact with reclaimed water and root crops consumed raw	All irrigation methods
	Class B	100	Accordance with WWTP discharge thresholds				Food crops consumed raw where the edible part is produced above ground and is not in direct contact with reclaimed water, processed food crops and non-food crops including crops used to feed milk- or meat-producing animals	All irrigation methods
	Class C	1 000						Drip irrigation or other irrigation method that avoids direct contact with the edible part of the crop
	Class D	10 000					Industrial, energy and seeded crops	All irrigation methods
Montenegro								
Albania								
Türkiye	Class A	0	10	no limit but 2 NTU (turbidity)	1	10	All kinds of food products that can be eaten raw	Surface and sprinkler irrigation
	Class B	200	30	30	1	10	All kinds of food products processed commercially for human consumption purposes + Plants that contain forage, fibber and seed plants that are not consumed by humans as food or pasture, commercial nurseries and grass planting areas	Surface and sprinkler irrigation
Syria								
Lebanon								
Palestine	Class A	200	20	30	2	6		
	Class B	1 000	20	30				
	Class C	1 000	40	50				
	Class D	1 000	60	90				
Israel	Class A	50	15	15	1	35	Restricted irrigation that is typically produced by a smaller reclamation facility receiving sewage of quality typical for less than 5 000 PE	
	Class B	No limit	30	45			Unrestricted irrigation that is typically produced by a larger reclamation facility receiving sewage of quality typical for greater than 5 000 PE	
Egypt	Class A	100	10	10	2	29	Fruits that are eaten fresh without peeling, such as apples, apricots, peaches, and grapes, etc.	All irrigation methods
	Class B	1 000	30	30			Dry grain and vegetables of all kinds (processed and cooked) + Fruit crops + Medicinal plant crops	
	Class C	5 000	60	50			Dry grain crops, fruit crops and medicinal plant crops + Non-food seeds + All types of seedlings that are then transferred to permanent fields + Roses and cut flowers + Ornamental trees + All fibber crops + Forage crops + Mulberry for silk production	Sprinkler irrigation method is not used for dry grain crops, fruit crops or medicinal plant crops
	Class D	No limit	350	300			Liquid and solid biomass crops + cellulose production crops + timber trees	
Libya								
Algéria	Class A	100	30	30	2	29	Non-restrictive irrigation: this category includes plants that can be irrigated without any restrictions.	All irrigation methods
	Class B	250					Vegetables that are only eaten cooked, Vegetables for canning or non-food processing	
	Class C	1 000					Fruit trees, Forage crops and shrubs, Grain crops, Industrial crops, Forest trees and Flowering and ornamental plants	
	Class D	No limit						irrigation technique that limits the wetting of fruits and vegetables
Tunisia			BOD = 30		1	21	All food crops consumed raw are forbidden	

	Classes	E. coli (UFC/100 mL)	BOD (mg/L)	TSS (mg/L)	Nb of microbiology parameters	Nb of physicochemical parameters	Uses	Irrigation method
Morocco	Class A	1 000		100	7	28	All kinds of food products that can be eaten raw	All irrigation methods
	Class B	No limit					Dry grain crops + industrial crops + forage crops + trees	
	Class C	No limit		2000				Located irrigation if public and workers are not exposed
WHO recommendations	Class A	1 000		20	2	1	Irrigation of vegetables (surface or sprinkler irrigated), green fodder and pasture for direct grazing, sprinkler-irrigated fruit trees	All irrigation methods
	Class B	100 000		35			Irrigation of cereals and oleaginous seeds, fibber, & seed crops, dry fodder, green fodder without direct grazing, crops for canning industry, industrial crops, fruit trees (except sprinkler irrigated) (e), plant nurseries, ornamental nurseries, trees, green areas with no access to the public.	
	Class C	No limit					Irrigation of vegetables (except tuber, roots, etc.) with surface and subsurface trickle systems (except micro-sprinklers) using practices (such as plastic mulching, support, etc.) guaranteeing absence of contact between reclaimed water and edible part of vegetables + crops od Class B	For crops from Class B: with trickle irrigation systems (such as drip, bubbler, micro-sprinkler and subsurface).

Table 3 shows quite different classes and thresholds between countries, but the parameters monitored are often the same.

There is also an important difference between countries in the number of parameters monitored, ranging respectively from 1 to 7 for the microbiological parameters and from 3 to 35 for physicochemical parameters.

Furthermore, in some countries like Algeria, the differences between water quality classes are related to microbiological parameters. Thresholds for physicochemical parameters are identical from one class to another.

Regarding the E. coli parameter, thresholds are often different between countries for the same uses. For instance, to irrigate vegetables eaten raw, E. coli concentration in reclaimed water must be 100 times lower in the EU than in Morocco.

Taking a step back, we can compare the different water quality classes, parameters, and thresholds with those recommended in the WHO guidelines: the number of parameters to be monitored and the requirements are much more lenient than those adopted by the countries.

B. MAIN AUTHORIZATION PROCEDURES AND REGULATORY CONSTRAINTS

Feedback from literature and from local and national experts have revealed a significant convergence in the control procedures and in the regulatory constraints. Below is a non-exhaustive list focusing on the main points:

- **Authorization procedures** with State water, agricultural and sanitary authorities are always required. In this authorization procedure, two documents are recurrent:

  - An **Incident Management Plan**, which requires the operator of the water reclamation and reuse installations to outline measures to be implemented in case of an incident.
  - A **Risk Management Plan**, notably present in European regulation. This plan adopts a preventive approach, requiring the operator to anticipate and to plan all measures to be implemented to minimize risks related to human health and to the environment.

  Enforcement is relatively strong for new planned water reuse schemes, but regularization of previously undeclared schemes is often slow (e.g., Maghreb).
- **Monitoring (lab analysis) of water quality** to assess performance of schemes and to ensure control of health and environmental risks (See section 5.1 above).
  The required water quality objectives sometimes lead to significant increases of project costs due to the treatment solution installation and operation. Water quality monitoring is also often expensive and challenging to implement (e.g., too many parameters used to be monitored in Italy for agriculture), and frequently there are difficulties due to the availability and to the capability of local laboratories.
- Immediate suspension of installations is required if failure is observed by state authorities, but in practice there is often too much at stake to stop irrigation in the middle of summer.
- One systematic obligation is to have a clear and distinct separation between sewage, drinking water, potentially rainwater, and reclaimed water networks to avoid any sources of contamination, whether it is reclaimed water mixing with raw wastewater or potable water mixing with reclaimed water. While this might seem obvious, it proves to be a real challenge in practice.
- No specific focus or monitoring of **emerging pollutants and microplastics** are required in the Mediterranean countries' regulatory documents and standards for water reuse.

Bibliography

Asano T. (1998). Wastewater Reclamation and Reuse. Technomic Publishing Co.: Singapore.

MedECC report, November 2020, 1st Mediterranean Assessment Report (MAR1)

Condom N., Lefebvre M., Vandome L. (2012). Treated Wastewater Reuse in the Mediterranean: Lessons Learned and Tools for Project Development. Plan Bleu, Valbonne. (Blue Plan Papers 11)

COSTEA, Benchmark - Agriculture reuse, 2022 + COSTEA, Maroc, 2022 + COSTEA, Algérie, 2022

European Environment Agency, Roddier-Quefelec, C., Spiteri, C., Veiga, J., Towards a cleaner Mediterranean: a decade of progress: monitoring Horizon 2020

FIT4REUSE, 2020, D8.7 - Inventory of the current legislative and policy frameworks addressing unconventional water resources treatment and application.

Guidelines for municipal water reuse in the mediterranean region, 27 May 2005, Barcelona, Spain

Jodar-Abellan, A.; López-Ortiz, M.I.; Melgarejo-Moreno, J. Wastewater Treatment and Water Reuse in Spain. Current Situation and Perspectives. Water 2019, 11, 1551. https://doi.org/10.3390/w11081551

Cerema, 2020.Réutilisation des eaux usées traitées - Le panorama français. Bron, France: Edited by Cerema (France), 46 p.

Melgarejo J., Prats D., Molina A., Trapote A. 2015. A case study of urban wastewater reclamation in Spain: comparison of water quality produced by using alternative processes and related costs. Journal of Water Reuse and Desalination, 6(1), p. 72-81. DOI: 10.2166/wrd.2015.147

https://water.europa.eu/freshwater/countries/uwwt

Mugdal S., Van Long L., Saïdi N., Haines R., McNeil D., Jeffrey P., Smith H., Knox J. 2015. Optimising water reuse in the EU – Final report prepared for the European Commission (DG ENV), Part I. BIO by DELOITTE in collaboration with ICF and Cranfield University.

Akissa Bahri, Francois Brissaud. Wastewater reuse in Tunisia: Assessing a national policy. 1999. https://doi.org/10.1016/0273-1223(96)00410-6

U.S. delegation summary, From Water Stressed to Water Secure: Lessons from Israel's Water Reuse Approach, March 2023.

Hussein Abdel-Shafy, Mona S. M. Mansour. Overview on water reuse in Egypt: Present and Future. January 2013.

COSTEA Réutilisation des eaux usées pour l'irrigation agricole en zone péri-urbaine de pays en développement : pratiques, défis et solutions opérationnelles – 2015v

R. Mujeriego et. al, The water reclamation and reuse project of El Prat de Llobregat, Barcelona, Spain, 2008

Agència Catalana de l'Aigua, La reutilització al Baix Llobregat, Barrera contra la intrusió salina a l'aqüífer del delta del Llobregat, Dossier de premsa

Area metropolitana de Barcelona, La Reutilització d'aigües i la seva progressiva entrada en servei, 54ª Reunió General Tècnica CUADLL, 2020

Area metropolitana de Barcelona, Depuradora i estació de regeneració d'aigua del Prat de Llobregat

Site de Area metropolitana de Barcelona + Aigües de Barcelona, 2018

https://vdocument.in/metropolitan-area-of-barcelona-the-baix-llobregat-metropolitan-area-of-barcelona.html

COSTEA "Reuse – Wastewater reuse in agriculture" initiative – Livrable 3B – August 2022.

World Health Organization (WHO), 2006. Guidelines for the safe use of wastewater, excreta and greywater (Volumes 1 – 4). https://www.who.int/publications/i/item/9241546824

Annexe 1 – National reference stakeholders involved in the study

Country	Reference stakeholders	Entity
Albany	Klodiana MARIKA	*Plan Bleu contact*
Algeria	Najet AROUA	Alger University
Bosnia -Herzegovina	Sabina HADZIAHMETOVIC	Hydro Institute Sarajevo
Cyprus	Popi KARAOLIA	GAIA-Laboratory of Environmental and Engineered Water Processes & Systems, Nireas-IWRC, University of Cyprus
Cyprus	Despo Fatta-Kassinos	GAIA-Laboratory of Environmental and Engineered Water Processes & Systems, Nireas-IWRC, University of Cyprus
Croatia	Damir ČIZMEK	INAQUA
Croatia	Ranko GASPAROVIC	Studio Auctor d.o.o.
Egypt	Rifaat ABDEL-WAHAAB	Water Management, NRC
France	Rémi DECLERCQ	ECOFILAE
Greece	Evangelia STAMOULI	*Plan Bleu contact*
Italy	Stevo LARNIC	UNIBO
Libya	Samia GRIMIDA	*Plan Bleu contact*
Malta	Manuel SAPIANO	Malta Energy and water agency
Morocco	Mohammed ELGHALI KHIYATI	Self-employed worker
Montenegro	Milica RUDIC	*Plan Bleu contact*
Palestine	Mohammad Said Al Hmaidi	Water Sector Regulation Council
Spain	Rafael CASIELLES	BIOAZUL
Tunisia	Mosbah ABAZA	*Plan Bleu contact*
Tunisia	Atef JAOUANI	UTM-ISSBAT
Türkiye	Özlem KARAHAN ÖZGÜN	ITUNOVA TTO

Some MED countries had no Reference stakeholders in the study.