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The advent of EU water reuse regulation in the Mediterranean region: policy and legislative adaptation to address non-conventional water resources utilization in agriculture

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1 **The advent of EU Water Reuse regulation in the Mediterranean region:**
2 **policy and legislative adaptation to address non-conventional water**
3 **resources utilisation in agriculture**

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5
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16 **Abstract**

17 The provision of safe, sustainable and accepted ways of water supply for the Mediterranean
18 basin by using non-conventional water resources is key to reducing the gap between
19 agricultural water demand and supply. The gap will only increase due to population growth
20 and climate change. To guarantee the proper exploitation of non-conventional water resources,
21 a unified EU regulatory framework is essential to harmonize diverging approaches among EU
22 member states. The article offers a review of the current policy and legislative frameworks
23 addressing non-conventional water resources treatment and application in agriculture in
24 selected Mediterranean countries, including non-EU countries. A particular focus is put on the
25 new EU Water Reuse Regulation of 2020. By combining literature review and stakeholders’
26 consultation under different techniques i.e., sentiment analysis, interviews with written follow-
27 ups and surveys, this work offers different visions from EU countries and non-EU countries
28 around the Mediterranean which might be affected by the regulation.

29
30 **Keywords:** water reuse; water scarcity; non-conventional water resources;
31 agriculture; regulation; the Mediterranean.

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36 Introduction

37 Global food production and demand are increasing (European Commission, 2019), as well as
38 worldwide water consumption, and they are all closely linked with the agricultural sector, the
39 larger water user globally. Water demand in the future is expected to even increase due to
40 population growth and climate change patterns (Lavrnić et al., 2017). The Mediterranean
41 region, together with its agricultural sector, has always been characterised by limited and
42 irregular availability of water resources. It is expected that the region will become even more
43 vulnerable in the near future due to climate change - e.g. drought events (Bucak et al., 2017;
44 WWAP, 2017)

45 In the case where the water available is not enough to satisfy water demand, non-conventional
46 water resources (e.g. treated wastewater) can be considered as a solution and a source to
47 overcome this gap. Different studies (Alcalde Sanza and Gawlik, 2017, 2014; Barbagallo et al.,
48 2012; Lopez et al., 2006; Mancuso et al., 2020) have shown how domestic wastewater reuse in
49 agriculture could support addressing water scarcity. Moreover, using non-conventional water
50 sources for irrigation purposes could also ensure that enough water of good quality is reserved
51 for drinking purposes.

52 However, apart from some technical aspects, the possibility to resort to this solution at a large
53 scale is currently hindered by obstacles mainly belonging to the *social* and *legal* spheres. In
54 terms of the legal ones, the lack of a unified legislative framework at the EU level was often
55 brought to the fore. This divergence among applicable frameworks is also evident across
56 Mediterranean countries. Among the countries in this region, Israel and Italy are often framed
57 as two extreme examples. Israel considered the leader in wastewater reuse in the Mediterranean
58 basin, requires around 10 parameters to be met for reusing wastewater, while in Italy, a country
59 where a small proportion of its treated wastewater is reused, around 50 parameters have to be
60 respected (Lavrnić et al., 2017). At a social level, the aversion of some stakeholders to legal
61 and technical innovations, in part also caused by these diverse attitudes, represents an extensive
62 burden factor encouraging the application of larger water reuse.

63 In order to overcome the legal and practical impasse generated by diverging frameworks across
64 the European Union (EU), the EU has adopted the new Regulation on minimum requirements
65 for water reuse for agricultural irrigation, applicable for all EU Member States from 26 June
66 2023 (REGULATION (EU) 2020/741). This aspect is included in the new Circular Economy
67 Action Plan (CEAP). The CEAP was implemented in 2020 by the EC and involves a series of
68 regulations to advance the circular economy in Europe. While this regulation intervenes at an
69 EU level, has several spill over effects on non-EU countries in the Mediterranean, as discussed
70 in this study.

71 This research focuses on the legal and policy framework for non-conventional water use in
72 agriculture in the seven countries that can be considered illustrative of the Mediterranean
73 region. Namely, they are Italy, Spain, France, Greece, Tunisia, Israel and Turkey. Even though
74 closely connected, these countries have different legislations that regulate the field of
75 wastewater reuse, and several of them do not have single reference legislation but actually,
76 their framework is built on *an aggregation of legislations*. The countries selected in this study
77 belong to the consortium FIT4REUSE¹, a European Research project funded under PRIMA -
78 Partnership for Research and Innovation in the Mediterranean Area.

79 The analysis of challenges and opportunities of water reuse in different geographical areas are
80 ample in the grey and academic literature, such as – respectively – the Innovation Deals project
81 (2018a, 2018b) and the SUWANU Europe project (2019) Kamizoulis et al. (2003), Kellis et

¹ FIT4REUSE website: <https://fit4reuse.org/>

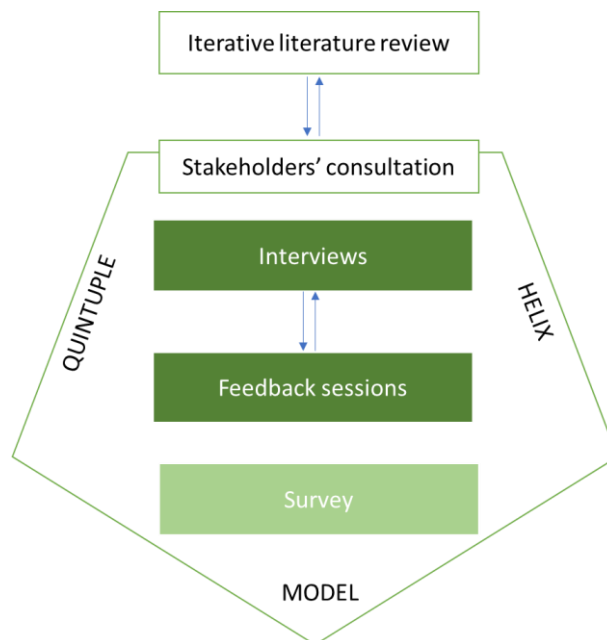
82 al. (2013), and Berti Suman and Toscano (2021). Besides the listed studies, the original
83 contribution of this to the scientific and academic debate is to provide an overview of the
84 current legislative and policy scene for non-conventional water resources treatment and usage
85 in the indicated Mediterranean countries, and an original discussion of socio-legal aspects
86 connected with the current status quo and progresses. Therefore, the objective of this research
87 is to identify and compare policy and legislative gaps, constant trends, and breakpoints,
88 together with key stakeholders aiming at co-developing alternative water reuse scenarios across
89 the Mediterranean region.

90 **Material and methods**

91 This work adopted a socio-legal lens of analysis as the aim of the study is the identification and
92 comparison of legislation and policy legislation of non-conventional water use in agriculture,
93 and the perception thereof by relevant stakeholders. As this study inspects a series of legal
94 innovations ongoing in the field, an empirical legal studies approach is adopted. This approach
95 involved the combination of literature review with collection and analysis of primary data
96 elicited from stakeholders' consultation as indicated in Figure 1 embracing the quintuple helix
97 model which engages diverse stakeholders. This work builds on an earlier study performed
98 within the framework of the FIT4REUSE project (Berti Suman et al., 2020). The present article
99 updates the reflection two years after the study was carried out, in particular taking stock of the
100 most recent (albeit not abundant) legal developments and of the attitude of the actors involved.
101 From a methodological level, the manuscript reflects the analysis of data collected on the
102 occasion of selected events, such as Water Reuse Events described below that occurred during
103 these two years, outcomes in the literature from 2022-2023, and from the deployment of a
104 survey, which provides key novelties to this work.

105 Figure 1. Methodological representation.

106



107

108

109 ***Iterative literature review***

110 An in-depth literature review was conducted following an iterative approach. Bibliographic
111 databases disclosing scientific articles and grey literature – i.e., research reports, conference

112 proceedings, and different studies from reliable sources – were consulted using keywords and
113 search under this theme and through a ‘snow-balling’ technique.

114 The legal review included textual analysis of EU and national legislation and regulations,
115 available in national archives and databases and selected based on existing studies identifying
116 them, such as Alcalde-Sanz and Gawlik (2017) and IMPEL (2018).

117 *Stakeholders’ consultation*

118 Stakeholders’ identification followed the quintuple helix model proposed by Carayannis et al.
119 (2012). This paradigm grasps university-industry-government-public-environment
120 interactions), the role of academia, industry, political system, media (including culture), and
121 the environment (natural and societal) as a subsystem of knowledge creation and innovation.

122 Identified stakeholders were engaged within different momenta under the following
123 techniques:

- 124 • Sentiment analysis of primary data, comprising the response by interested and
125 concerned actors to the consultations launched by the European Commission (EC)
126 under the release of the EU Proposal for a Regulation on water reuse (European
127 Commission, 2018) adopting a socio-legal lens of review on the responses made
128 publicly available on the EC’s webpage.
- 129 • Several interviews (**10**) with experts were performed to cover all countries represented
130 in this study. The access to them was thanks to the FIT4REUSE project, as they were
131 already part of the project or suggested by a project member. Interviews helped to
132 contrast findings from the literature review while gathering new information.
133 Interviews were conducted online with each participant, were recorded, and lasted for
134 around 1 hour. The interview formatting was semi-structured, mixing general questions
135 asked to each participant and country-specific questions, leaving also space for
136 spontaneous insights emerging from the interviewed person. Detailed questions can be
137 found in Supplementary Materials (SSMM).
- 138 • Feedback sessions (in virtual and physical focus groups settings) were organised with
139 actors within the network of the FIT4REUSE project under the umbrella of the Water
140 Reuse Forums and with external actors on occasion of the Water Reuse Day 2020
141 (during ‘Ecomondo’) which aimed to corroborate the results of this work. Also,
142 interviewers participated in these sessions to ensure information was well captured.
- 143 • An online survey was published to clarify some results from the interview in June 2022.
144 The survey was allocated in an online platform called Multi-stakeholder Water Reuse
145 Platform, where several stakeholders covering the quintuple helix structure were
146 invited to take part in it (**47 responses** were collected from all countries represented in
147 this study). Questions can be found in SSMM.

148 Thanks to the combination of literature review and the described participatory approach, it was
149 possible to define current legislative and policy scenarios and foresight on how they will look
150 after implementing the EU Water Reuse Regulation. In particular, the legislative scenarios
151 documented were systematized in a table working as a ‘live inventory’ of the status quo for the
152 selected countries of interest. For each legal instrument identified, it was reported the Name,
153 Country/Region, Type of instrument, Issuing body, Date of issuing Status, Updates/Notes,
154 Targeting agriculture need (y/n), Targeting aquifer recharge (y/n), Targeting other uses (y/n +
155 entry), Implementation, Usage, Social perception. Details are available in SSMM.

156 **Results and discussion**

157 *Insights into each country*

158 This section combines the result of a country-specific legal review with inputs from the
159 interviews. Quotation marks and italics signal quotes taken verbatim from the interviewees'
160 statements. Therefore, the quotes aim to reflect experts' opinions on the matter.

161

162 *Italy*

163 The Ministerial Decree n. 185/2003 is the cornerstone legislation on technical norms for
164 wastewater reuse. There is available a summary of the Italian legislative framework, including
165 selected regional legislation which was realized for the Innovation Deal project (2018a and
166 2018b). In April 2023, Italy launched the Decree-Law n. 39/2023 (Decreto-Legge n. 39/2023
167 in Italian), to be aligned with the Regulation (EU) 2020/741 of the Parliament European Union
168 and the Council of 25 May 2020, as described in Article 7 of the Italian Decree-Law, referring
169 to the reuse of purified wastewater for irrigation use. This Decree-Law was released due to the
170 water scarcity faced by this country.

171 The interviewed expert mentioned as a benchmark the Ministerial Decree n. 185/2003, and
172 highlighted ISPRA's work as part of the afore-cited IMPEL project (2018) as relevant for an
173 integrated review of water reuse legislation across Europe, while the survey has also reported
174 the Proposal for a Regulation of the European Parliament and of the Council on minimum
175 requirements for water reuse (COM/2018/337).

176 When evaluating the implementation of such legislation, it resulted that some regions are
177 regulating the field with their legislating measures (e.g., regional decrees), for example, the
178 region Puglia, regardless of the overarching national regulation. Regions can have their own
179 regulations depending on their needs, as in the example of Puglia due to water scarcity
180 problems, they have their own water reuse promoting measures, as indicated in their Regulation
181 (named in Italian as *Regolamento Regionale, n. 8 Norme e misure per il riutilizzo delle acque*
182 *reflue depurate D.Lgs. n.152/2006*). Experts also highlighted as a barrier, when comparing with
183 other countries, that Italian legislation mandates have very stringent limits for numerous
184 compounds, being one of the strictest legislation for water reuse in Europe much more than
185 other Mediterranean countries such as Spain, for example, – before each country implemented
186 the Regulation (EU) 2020/741 thus creating a more harmonized set of standards across the EU
187 – especially for *E. coli* and metallic compounds.

188 Structural and governance problems were also identified as barriers to the adoption of non-
189 conventional water uses “*The real problem is the governance: the water authority has to treat*
190 *water up to standards and deliver it for free, and then the irrigator can charge the farmer*”.
191 With regards to promoting paybacks for the reuse, the interviewee noted that water scarcity
192 was the real trigger for authorities to promote treated water, for example with the water tariff
193 scheme promoting reuse introduced by the Italian Regulatory Authority for Electricity Gas and
194 Water (*Autorità di Regolazione per Energia Reti e Ambiente*).

195 When going into the implementation of the legislation, several water treatment plants that are
196 applying the Ministerial Decree perform water reuse, which – however – in Italy is only
197 allowed for irrigation and not for aquifer recharge, which is still forbidden in Italy.

198 From users, such as farmers or consumers, the use of non-conventional water was perceived as
199 positive whenever it is accompanied by economic advantages “*Farmers are not reluctant to*
200 *use non-conventional water reuse, as far as this is cheaper than water from the ‘Consorzi di*
201 *Bonifica’ (i.e. irrigators); the problem is not even on the consumers’ skepticism as often the*

202 *water with which a product was irrigated is not reported to consumers. The obligation to report*
203 *by sellers is contained in Business2Business sale, but this is not displayed to consumers.*
204 *Reporting this information could even be a trigger for consumers to opt for a more sustainably*
205 *irrigated product. But of course, it depends on the type of consumer”.*

206 A big concern of the consumers in Italy is that they often distrust the (water) management from
207 the authority. As a result, they also frequently do not trust the safety of drinking water as well
208 as innovation in the sector, partially due to failed risk communication strategies by the
209 competent authorities (Carrozza and Fantini, 2016). Social revulsion may extend as an effect
210 of the COVID-19 pandemic (traces of the virus were found in sewages of Italian cities) and the
211 relater water safety concerns, affecting especially the social acceptance of reuse (Dettori et al.,
212 2019; Mancuso et al., 2021; Reuters Staff, 2020).

213 *Key stakeholders in Italy*

214 Irrigators and farmers, as well as water utilities, are identified as relevant in this field. Before
215 the EU regulation, they had to find an agreement every time they wanted to initiate a water
216 reuse experience. The new Regulation does not require finding this case-by-case agreement. ,
217 while it will include an overarching harmonized process suggested by the EU benchmark.
218 Another stakeholder, consumers, are not perceived as key by the expert, as often they are not
219 informed and they should be ‘educated first’. *“In Singapore, they are treating water up to*
220 *drinking water levels! There, it resulted that the highest the education level of the person, the*
221 *more their skepticism towards non-conventional water. Targeted education may help. But cost-*
222 *effectiveness is the real drive”.*

223 Environmental organizations (which have been already very active in desalination-related
224 discussions) like Legambiente bringing a different perspective and often reflecting the (or,
225 better, ‘a’) civic perspective on the matter should also be considered as relevant actors in this
226 field. While at the institutional level, Ministries of the Environment and Environmental
227 Protections Agencies were mentioned as central players as well.

228 *Spain*

229 The Royal Decree 1620/2007 (Real Decreto 1620/2007, in Spanish) was identified by the
230 expert as the key instrument which regulates all types of reuse, including industry, forestry,
231 and municipal reuse. The decree was also an inspiration source for other countries in Europe.
232 Once this Royal Decree was launched, it was very innovative, boosting reuse in Spain by up to
233 11% thanks to a detailed legal framework. The survey also indicates that Regulation (EU)
234 2020/741 on minimum requirements for water reuse was a relevant tool to be considered for
235 Spain.

236 The expert remarked on the fact that the provision is quite recent, from 2007 as *“Spain did not*
237 *have the same perception as for example Israel of the pressing need to reuse. However, for*
238 *cultural differences, we cannot compare Spain to Israel. Around the ‘80s Spain experienced*
239 *numerous droughts, but until recently they did not have much of this need. However, especially*
240 *in the area of Murcia where the need for water for agriculture was pressing, they were pushing*
241 *for reuse”.*

242 The answers provided in the survey are aligned with this trend, reporting that in those areas
243 where water scarcity is pressing, water reclamation is more accepted than in other areas with
244 lower needs. Regarding social acceptance, there is still a way to go, as the adoption of this
245 water use cannot easily be adopted, with several challenges identified into technicalities and
246 uncertainty o long effects on pollutants remaining in reclaimed water.

247 In April 2023, Spain published their national regulation, the Royal Decree-Law 4/2023 (Real
248 Decreto-Ley 4/2023 in Spanish), to implement the Regulation (EU) 2020/741, aiming to better
249 regulate the use of non-conventional water reuse, especially in those areas of the country more
250 affected by water scarcity. The expert did not mention this regulation because it was issued
251 after the interviews were conducted.

252 *Key stakeholders in Spain*

253 The influence of the irrigators' community is key in this field due to their water sensibility, in
254 terms of quantity and quality, followed by consumers. An example of irrigators is the Spanish
255 National Federation of Irrigators and the Mediterranean Federation of Irrigators, while
256 consumers would be the Spanish *Confederación de Consumidores y Usuarios*. Lastly, cross-
257 EU environmental NGOs such as Greenpeace and organic producers' associations.

258 *France*

259 The Decree of 2014 modifying that of 2010 and regarding only irrigation (agricultural and
260 recreational areas including golf courses and sports fields) presents the legislative framework
261 (Arrêté du 2 août 2010, in French). In the 2014 revision, a mandatory experimental phase of 6
262 months considered to be too expensive and too burdensome was removed from the 2010
263 original text. France also released a Decree in August 2023 (Décret n. 2023-835 du 29 août
264 2023, in French) to prepare the adaptation of the French regulation to the Regulation (EU)
265 2020/741. The current state of this document still needs to include information referring to the
266 use reclaimed water in agriculture.

267 The expert qualified the legislation as very well enforced, corroborating the fact that all new
268 projects have to comply with it. According to the expert, the legislation is very strict in terms
269 of security distances between non-conventional water use points and sensitive areas, mainly
270 when using sprinkler irrigation, thus making it more difficult to use for irrigation in urban green
271 areas.

272 In the subsequent survey, a response for France mentioned the Order of 26 April 2016 (Arrêté
273 du 26 avril 2016, in French) on the reuse of wastewater for crops, which amended the order of
274 2 August 2010 on the use of water from urban wastewater treatment for the irrigation of crops
275 or green spaces, by postponing the compliance of existing installations scheduled for 2016 to
276 the end of 2019, which may signalize existing difficulties to comply with the stringent
277 regulations.

278 Part of the acceptance of non-conventional water will rely on prices, as farmers are not used to
279 paying as much for water "*The major problem is with socio-financial acceptance in terms of*
280 *willingness to pay. Consumers' scepticism is instead getting better as they seem to consider*
281 *more and more the environmental and socio-economic benefits behind water circular*
282 *economy*". Another factor highlighted was the presence of COVID-19, as consumers'
283 opposition may increase, and there may be a tendency to associate treated water with viruses.

284 *Key stakeholders in France*

285 As seen in other countries, Municipalities are crucial stakeholders. They are often the project
286 leaders, which also report to the national level. Other governance levels such as Regions are
287 key as they are the major subsidizers together with water agencies. Water private companies,
288 in particular the large ones (such as Veolia and Suez) are also important in driving and shaping
289 the standards. "*Farmers associations are still organizing themselves in the field: water reuse*
290 *is still a new topic for them*". Instead, consumers and NGOs were not that central in the debate
291 in France, according to the expert, but they need to be put at the core of the discussion
292 (especially citizens).

293 *Greece*

294 The Common Ministerial Decision on Measures, Limits and Procedures for Reuse of Treated
295 Wastewater n. 145116 of 2011, updated in 2013, both for industrial and municipal water reuse
296 are the pillar legislation named in the interviews. Prior to 2011, there was a Health Code
297 (E1b/221/1965) that vaguely regulated wastewater reclamation. This code was updated in 2008
298 with very strict legislation (Ministerial Decision n. 133551/FEK 2089/9-10-2008) that set
299 extremely stringent criteria for wastewater reclamation.

300 The reuse in Greece is very low compared to neighbour countries such as Cyprus and Israel,
301 notwithstanding the dedicated law. *“The direct reuse of treated water is less than 2% of all*
302 *Greek water. The ‘mixed reuse’ is a bit more, around 7%”,* noted the expert. An interesting
303 aspect was raised by the expert: *“The problem is that in Greece the majority of the people live*
304 *in Athens and Thessaloniki, thus the location of the demand is far away from the location*
305 *(agricultural areas) where non-conventional water is produced (cities). The costs of bringing*
306 *water from where it is produced to where it is needed are very high. Even if we would water*
307 *all of Athens’ green areas with non-conventional water produced in Athens, we would never*
308 *reuse enough water. Provided that we can increase this amount, we would still not go for more*
309 *than 10-15% of the reuse. There is an overarching, structural problem of matching demand*
310 *with supplies. This is different from cities such as e.g. Italy where many smaller cities are closer*
311 *to agricultural lands.”*

312 The expert was positive towards the legislative intervention: *“The law, anyways, is a big step*
313 *ahead boosting reuse, but we have a bottleneck that is not social but it is really about how*
314 *Greece is structured. The main barriers identified are related to geographical and technical,*
315 *rather than legal features are hampering reuse in Greece”*. Greek legislation was also said to be
316 very ‘infant’ as it does not address the reuse of rainwater and grey water. Mandated limits for
317 nitrogen and phosphorus (nutrients) are not very strict, whereas Greece has strong limits in
318 terms of biological compounds, *E. coli* etc. These nutrients could be even beneficial for crops
319 as having a fertilizing effect. The survey also reported this feedback, where a respondent for
320 Greece noted that a major driving force in the policy field is needed to promote water reuse.

321 *Key stakeholders in Greece*

322 Municipalities are key as they are often responsible for drinking water treatment, drinking
323 water distribution, wastewater collection and wastewater treatment or reuse. Other stakeholders
324 are tourist associations and hotel structures due to the intrinsic need for water used in the
325 touristic facilities. The touristic activity embodies a great demand for water (for irrigating
326 gardens and tourist areas) while generating an increase in the production of water to be
327 theoretically reclaimed.

328 *Tunisia*

329 The Tunisian Water Code of 1975 (Law n. 75-16 of 31 March 1975, Loi n. 75-16, in French)
330 and its modification by Law n. 87-35 of 06 August 1987, Law n. 88-94 of 02 August 1988 and
331 Law n. 2001-116 of 26 November 2001 (Loi n. 2001-116, in French) was one of the two types
332 of legislation highlighted by the expert in terms of treatment and reuse of non-conventional
333 water resources.

334 The Water Code presents the overarching legislation covering the water sector and all decrees
335 and ordinances that apply to water and wastewater treatment refer to that code. The Code is
336 under revision since 2016 and should be released in an updated version shortly (as also
337 discussed in Akissa, 2001). Differently from other countries studied, Tunisia has all-embracing
338 legislation covering the water sector that applies to water and wastewater treatment. The still
339 ongoing revision of the Code will also have an impact on non-conventional water reuse

340 regulation according to the expert. However, “*Many other African countries are turning to*
341 *regulate water reuse just now, so we are frontrunners, but the problem for us is*
342 *implementation*”.

343 In the second stage, the Tunisian standard NT 106-02 of 1995 (Norme Tunisienne 106.002
344 (1989) relative aux rejets d'effluents dans le milieu hydrique) was highlighted. This standard
345 contributes to the proper application of Decree n. 85-56 of 02 January 1985 (Décret n. 85-56,
346 in French) relating to the regulation of discharges into the receiving environment and of Decree
347 n. 79-768 of 08 September 1979 (Décret n. 79-768, in French), regulating the conditions of
348 connection and discharge of effluents into the public sanitation network. It was elaborated by
349 four different Ministries showing how transversal is this matter considered. The standard,
350 approved by the Decree of the Minister of National Economy of 20 July 1989 (Arrêté du
351 ministre de l'économie nationale du 20 juillet 1989, in French) aims at defining define
352 specifications relating to effluent discharges into the public maritime domain, the public
353 hydraulic domain and public sanitation pipelines.

354 The quality of the effluent is defined according to the type and specificity of the receiving
355 environment. The Decree n. 2001-1534 is regulating the conditions of connection and
356 discharge of effluents into the public sewerage (Décret n. 2001-1534, in French). In addition,
357 the Decree n. 2005-1991 is defining the modalities of environmental impact assessment (Décret
358 n. 91-362 in French). Since March 2018, this standard has been revised by the Decree n. 2018-
359 315, setting limit values for the release of effluents in the environment (Décret n. 2018-315, in
360 French). Annex 1 provides the limits for the three receiving environments of treated
361 wastewater, namely (1) public hydraulic domain (rivers and similar streams), (2) sanitation
362 facilities and (3) public maritime domain (sea or salt lakes). Annex 2, in the view of the expert,
363 is the most innovative as the standard identifies industry-specific limits for treated water. These
364 particularities in the standards reflect the fact that different industries have different impacts
365 on the environment in terms of the quality of the water they release.

366 Furthermore, the Tunisian standard NT 106-003 of 1989 (Norme Tunisienne 106.002 (1989)
367 relative aux rejets d'effluents dans le milieu hydrique), defines the physical, chemical and
368 biological specifications of treated wastewater to be used for agricultural purposes and was a
369 relevant document raised by the expert. This complements the Decree n. 89-1047 of 28 July
370 1989 (Décret n. 89-1047 du 28 juillet 1989, fixant les conditions d'utilisation des eaux usées
371 traitées à des fins agricoles), setting the conditions for the use of treated wastewater for
372 agricultural purposes and the frequency of control of each parameter, and its modification by
373 the Decree n. 93-2447 of 13 December 1993 (Décret n. 93-2447, in French).

374 Different decisions were issued, for example, the Decision of the Minister of Agriculture of 21
375 June 1994 which listed the crops that can be irrigated with treated wastewater (Arrêté du
376 ministre de l'agriculture du 21 juin 1994 in French), or the Decision of 28 September 1995
377 (Arrêté des Ministres de la Santé Publique, de l'Environnement et de l'Aménagement du
378 Territoire et de l'Agriculture du 28 septembre 1995, in French) introduced to regulate the
379 requirements for agricultural wastewater reuse projects. Moreover, the Common Decision of
380 the Minister of Agriculture and the Minister of the Environment and Local Affairs was issued
381 on 29 December 2006 (Arrêté conjoint du ministre de l'agriculture et des ressources
382 hydrauliques et du ministre de l'environnement et du développement durable du 29 décembre
383 2006, in French), in relation to sewage sludge uses in the agricultural sector and the modalities
384 for their management by the farmer.

385 The expert highlighted the innovation denoted by the Decree n. 2018-315, as it set parameters
386 for the release of effluents in the environment. “*The new regulation brought forward a change*
387 *that was asked by environmentalists, experts and industrials. The idea is to push actors to foster*

388 *better protection of the environment. But sometimes it is just technically difficult to respect the*
389 *environment, especially for the majority of industries in Tunisia e.g. the olive oil production*
390 *mills which are small having limited human and financial resources. Tunisian industrial tissue*
391 *is mainly composed of manufacturing industries, e.g. textile and agri-food industries that do*
392 *produce not much-added value that can then be reinvested in the environment. Meanwhile,*
393 *they have a major negative environmental impact that make pressure on water resources and*
394 *generates high amounts of polluted effluents. So the context is difficult!”*

395 When discussing the implementation of the new standards: *“The new regulations of 2018 have*
396 *given a period of adaptation of 5 years, but – with a lot of political turmoil since the revolution*
397 *of 2011 and now with the COVID-19 outbreak – it is difficult to apply rigorously the regulation*
398 *as it may cause a social disturbance. However, compared to the situation in the other African*
399 *and Arab countries, the Tunisian context is more advanced in terms of respect for the*
400 *environment with a regulatory and institutional framework more developed.”*, affirmed the
401 expert.

402 In the survey, some respondents expressed doubts regarding the application of this legislation
403 framework locally, while it was proposed the use of penalisation tools for those industries
404 polluting the water with measures to guarantee the water comes back to non-polluted status.

405 *Key stakeholders in Tunisia*

406 From the beginning of the food supply chain, farmers and industries are key as are directly
407 involved in the wastewater treatment and reuse ecosystem, while environmentalists and
408 environmental professionals are also relevant in this debate.

409 *Israel*

410 In this country, above 85% of the treated wastewater is used for irrigation (UNECE, 2019).
411 The standard legislation for water reuse includes; permits for Agriculture from 1999 issued by
412 the Israeli Health Ministry; the Principles for effluent reuse for the city, recreation and industry
413 from 2003; the Ministry of Health Regulation of 2005 and Effluent Quality Standards and
414 Rules for Sewage Treatment Regulations of 2010, providing for agricultural irrigation and
415 inspired by the California Code of Regulations of 2000 (Title 22 division 4, chapter 3).

416 In the survey, it was highlighted that the Israeli Health Ministry permits for infiltration of flood
417 water in drinking water aquifers, already from the '90s.

418 The expert indicated that *“both the use of treated and of desalinated water for irrigation is not*
419 *innovative at all in Israel. Actually, it is quite standard, we have been reusing for many years*
420 *as we did not have other options than to reuse. In Europe instead, the practice is rather new*
421 *as it is a pressing demand that emerged just now associated with climate change-related*
422 *distress.”*

423 Public acceptance was also noted under positive terms: *“In Israel, people accepted the reuse*
424 *of non-conventional water also more easily, as they needed to, for being food-independent.”*

425 This country is perceived as a leader in the field due to different innovative aspects such as *“it*
426 *is in how we do that, which is also related to regulation”*. In particular, in the view of the
427 expert, innovation is in how Israel regulates the discharge of water into the sea to avoid high
428 levels of nitrogen and prevent algal bloom in the sea (for this aim, regulations dictate limits
429 and obligations to remove nitrogen from the sea); how they reduce energy consumption for
430 performing reuse operations (for reducing CO₂ emissions associated with reuse entails high
431 energy consumption); and how the country looks for ways for faster irrigation rates.

432 Responses from the survey indicate that the regulations for water reuse and non-conventional
433 water use are mandatory and properly enforced by governmental offices. The social acceptance
434 of reuse is widespread and the implementation is elevated with high-quality standards, while
435 work is still needed to make regulation authorities stronger, i.e. well budgeted and respecting
436 the law.

437 *Key stakeholders in Israel*

438 The main actors in the field are innovators in academia, innovators in utilities (such as Mekorot)
439 and innovation providers (those that provide commercial products). Israel Ministry of Health
440 determines which kinds of crops can be irrigated with recovered wastewater. Israel Water
441 Authority mandates maximum levels of chloride and boron in desalinated seawater so that it
442 can be used for agriculture after it has been used for the domestic supply. Therefore, these two
443 public actors play a key role in Israel.

444 *Turkey*

445 Annex 7 of Wastewater Treatment Plants Technical Factsheet published in Turkish Official
446 Gazette dated 20 March 2010 n. 27527 issued by the Ministry of Environment and
447 Urbanization, which has replaced and incorporated the former Bulletin of 1991 regulating
448 irrigational wastewater reuse is the main reference legislation in Turkey. Annex 7 provides for
449 treated water to be used for feeding wetlands designated for recreational purposes; as industrial
450 cooling water and as industrial process water. In Bareera and Büyükgüngör (2019) a practical
451 overview of non-conventional water and reuse trends in Turkey can be found.

452 Current standards applied in Turkey are based on the regulations of 2010 and the former
453 legislation from 1991 (which resembles the EU Regulation in as much as it often refers to the
454 Urban Waste Water Treatment Directive of 1991). The expert reported that *there will be a new*
455 *regulation considering whether the direct use of treated non-conventional water can be*
456 *admissible.*

457 Even though several efforts are put in place to promote safe wastewater reuse, the expert
458 considers that they are not enough, being the industry the actor imposing some standards “*but*
459 *farmers would irrigate with whatever, so this is more a concern of us experts*”...“*the*
460 *authorities only check whether treatment processes are appropriate based on the quality*
461 *standards set by the industry*”. Contrary, for water discharge into effluents, the Ministry of the
462 Environment and Urbanization has to perform stricter checks.

463 Experts deemed that the 1991 regulation is well implemented and enforced, while currently
464 changes are occurring, as the authority is in the process of trying to change it (e.g. for what
465 regards colour parameters), there are quite some protests on that (e.g. the textile industry was
466 strongly against the colour parameter).

467 From the survey, it is perceived that water reuse from non-conventional water resources is not
468 implemented at high levels, while it is mostly done by metropolitan municipalities. There is no
469 enforcement on water reuse. A limit identified is in the use of untreated sewage directly for
470 irrigation, under water scarcity conditions, by local farmers without any permission. It is
471 pointed out that the irrigation water resource is not controlled, and the social acceptance could
472 be higher if data on the irrigation water quality is shared publicly and/or if it is certified as
473 appropriate for irrigation by a public or private institution for the crops, fruits, etc.

474 *Key stakeholders in Turkey*

475 The food industry, encompassing all segments of the supply chain up to the industry is relevant
476 in this field. Moreover, it was noted that “*Consumers, on their side, rarely pay attention to the*

477 *source of water with which the products they buy are irrigated, this also applies for example*
478 *pesticides. Therefore, they are not big stakeholders in the field now.”*

479 ***Analysis of country’s position***

480 The previous sections provided an analysis of each participating countries’ legislative
481 framework for water reuse, the overarching EU framework including the new Water Reuse
482 Regulation and each participating country’s position towards the practice in general and with
483 regards to the new Regulation, more specifically. Based on that, distinctive traits having both
484 a positive and a negative impact on the realization of the practice are isolated as barriers or
485 opportunities, and analysed.

486 The following list indicates the distinctive trait associated with a country or countries
487 (country(ies) “standing” out compared with others as a distinctive trait) and the implication of
488 the new EU regulation on this particular trait.






- 489 • Strictness of the reclaimed water standards: in Italy, this represents a barrier to
490 reuse, and this could push the new regulation to more relaxed limits.
- 491 • Cumbersome governance of reclaimed water processing: in Italy, this represents a
492 barrier to reuse, the new Regulation streamlines the governance process.
- 493 • Miscommunication on the risks associated with water reuse: in Spain and Turkey
494 (in the past) this represented a barrier to reuse, the new Regulation imposes the
495 obligation of information to the public and among actors in the process. It does
496 apply to Spain but not to Turkey.
- 497 • Strict regulation of the space between permitted use of non-conventional water and
498 urban areas: In France, this represents a barrier to reuse, the new Regulation
499 incentivizes the reuse by relaxing such minimum distances.
- 500 • Applying certain standards to all types of water reuse applications: In France, this
501 represents a barrier to reuse, the new Regulation provides for tailor-made
502 application of stricter standards: i.e., only for the uses with the highest health risk.
- 503 • Tradition of ‘cheap’ water for farmers: In France, Greece, Tunisia, and Turkey this
504 represents a barrier, as farmers they might give for granted getting “cheaper” water,
505 therefore the new Regulation stimulates the introduction of financial incentives for
506 farmers adopting water reuse practices.
- 507 • Cultural beliefs, e.g., the idea that non-conventional water is ‘impure’: In Tunisia,
508 it represents a barrier to reuse, the new Regulation does not apply but Tunisia could
509 take inspiration from the relevant provisions on communication to the public
- 510 • Innovative standards, stringent but not excessive, balancing interests: in Spain, this
511 could boost reuse, the new Regulation takes inspiration from the Spanish standards.
- 512 • Matchmaking offer and demand, especially in tourist areas: In Greece due to the
513 difficult geographical conformation, this combination would boost reuse, the new
514 Regulation takes inspiration from experiences of matching offer and demand.
- 515 • Creation of eco-labels to inform the consumers of the positive environmental
516 footprint: In Turkey, this could boost reuse as it could increase public awareness,
517 the new Regulation stimulates measures to engage the public and share knowledge
518 on the benefits of water reuse, while does not apply directly to this country.

520 ***Integrated results***

521 An integrated per-country and comparative analysis of the legal data coupled with data on
522 usage, implementation, enforcement, and social perception of the instruments discussed,
523 collected through interviews with key informants, lead to the following results.

524 Among factors hindering and triggering reuse, the key aspects have been reported in Table 1.

Table 1. Factors hindering and triggering reuse in most of the studied countries.

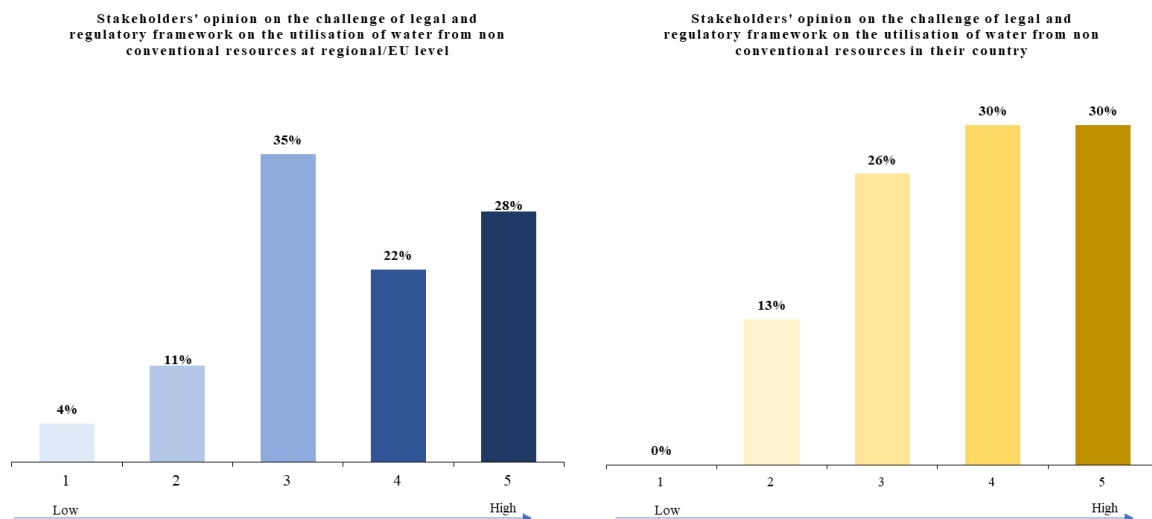
	Technical 	Administrative/legislative 	Financial 	Stakeholders 	Other 
Factors hindering reuse	Technical problems have been highlighted in several countries; Limited capabilities in assessing real risks for water quality.	Stricter limits at the national level, compared to the EU standards; Cumbersome water governance structures; Unclear paperwork brought by the new EU Regulation which may be long and complex; Need to respect minimum distance from urban areas for using treated water in irrigation; Denial of permission once already built the treatment plant; Political turmoil that pushes the authority to be more lenient with industries in terms of complying with regulation; Relatively late adoption of reuse regulation compared to other countries, thus still infant legislation or scarcely applied.	Not sufficient monetary incentives for reusing water; High reuse costs for farmers who do not want to pay for water.	Lack of agreements between stakeholders; Lack of trust: of farmers' operators or consumers in general towards the public operator (governance issue); Strong lobbying against this type of water use; Miscommunication of the risks associated with water reuse or lack of transparency towards farmers/users; Industries too weak for innovating (e.g. mostly manufacturing industries that produce not much-added value that can then be reinvested in the environment, such as the textile industry in Tunisia); Gap between awareness among the different named stakeholders	Unfavourable country structure: where the location of the demand (e.g. for Greece, the majority of the population lives in Athens) is far away from the location (agricultural areas) where non-conventional water is produced (cities), and the costs of bringing smaller cities closer to agricultural lands); Cultural barriers (e.g. Tunisia, water containing urine is impure).
Factors triggering reuse	Being technologically 'ready'; Stimulating trust among the users.	The EU single benchmark can harmonize the standards adopted EU-wide and in neighbouring countries; It could remove bottlenecks due to different standards and push the non-EU country to align with them if they wish to trade with Europe; An EU legislation that streamlines the water reuse processes with a strong political will; innovative legal framework for water reuse used as a stimulus for other geographical contexts.	Incentives in the water tariff as currently in the EU Regulation; Crops sold at a higher price; More willingness to pay for water or that do not survive if not irrigated sufficiently	Water scarcity is perceived as an urgent issue (longstanding or more recent perception) reuse could be perceived as a way to support food security and overall national independence/security from other countries; Synergies between various organizations; engagement of environmental organizations bringing a different perspective and often mirroring the (or 'a') civic perspective; the willingness of non-EU countries to show alignment with EU legislative status quo; targeted education for all stakeholders; training and support for farmers; strong lobbying in favour; Sharing best practices among countries with different standards	Touristic areas with large demand need for water (e.g. for irrigating gardens, or hotel facilities)

527 Among the divergences, the Regulation (EU) 2020/741 on minimum requirements for water
 528 reuse will be very relevant for the EU countries studied (that are, Italy, Greece, France and
 529 Spain), while other Mediterranean countries are perceived as more advanced in this field (e.g.
 530 Israel), and for them the proposed text is not perceived as innovative. Another noteworthy
 531 aspect is the circularity of the production chain. Crops – when irrigated with wastewater – can
 532 result in more sustainably irrigated products. This is seen either as a trigger for consumers to
 533 opt for a certain products over another (e.g. Ecolabels in Turkey and Greece) but also as a
 534 potential disincentive, discouraging consumers, such as in France. Currently normative does
 535 not include any obligation to inform consumers about source of water for irrigated products,
 536 and this absence of obligation could make consumer perception on water reuse less relevant.

537 Figure 2 shows the results from the survey regarding stakeholders’ opinions from 9 countries
 538 (from those analysed in this work, plus Germany and Portugal). While at the EU or regional
 539 level, around 35% of the respondents consider a moderate challenge to the utilisation of non-
 540 conventional resources due to the legal and regulatory framework, followed by 28%
 541 considering this topic a high challenge; at the country level, most of the respondents (around
 542 60%) considering this a high challenge. These results might show more clarity in instructions
 543 given at a higher level than in the country.

544

545 Figure 2. Results from the survey on stakeholders’ opinions.



546

547

548 Aligned with the results of the interviews, over 85% of the respondents consider that the
 549 utilization of water from non-conventional resources increases water security for society.

550 *Main limitations*

551 This work does not capture all country-specific nuances and the other local legislative progress,
 552 as well as other socio-legal and perceptive influences that stakeholders in participating
 553 countries are witnessing. In fact, the selected expert interviews and the survey’s responses
 554 cannot be considered representative of the views and perceptions of different sectors and
 555 segments of society. Furthermore, most of the interviews and the survey were performed
 556 remotely, whereas a period of field research could have helped the researchers to deepen their
 557 understanding of the recounted dynamics.

558 This study discusses a matter in rapid progress as the new EU Regulation is leading a movement
559 of adaptations in each country, affecting both EU MSs and non-EU countries and future
560 research should be monitored closely.

561 From a methodological perspective, future research should meet systematic empirical insights
562 into the effects of the recent EU Regulation on public acceptance of treated water reuse in the
563 sector. A multi-stakeholder approach should be considered, taking on board unstructured
564 ordinary citizens, beyond the most targeted ones (e.g. consumer organisations or industries).
565 Applied research should also investigate the influence of public engagement in the process on
566 individual and collective trust attitudes towards reuse practices, such as under the engagement
567 of lay citizens in research on (treated) water quality ('water citizen science') and of the use of
568 citizen-operated water monitoring technologies based on sensors combined with advanced data
569 analysis techniques and maps ('water citizen sensing'). Innovative science communication
570 methods – for example using audio-visuals and comics – could ensure that risk communication
571 over the issue is appropriate and reaches the sought audience.

572 A successful example is the recent citizen science project – named 'Off the Roof' – launched
573 in the U.S. to respond to increasing demands on diminishing water supplies and to the need of
574 using more local water supplies. The idea was to use the alternative water source represented
575 by roof runoff for household use for both potable and non-potable applications. Due to a lack
576 of data on the potential human health risks, a data-gathering task was entrusted to local
577 volunteers which collected samples from rain barrels, delivered thanks to the help of students
578 to the laboratory in charge of the analysis. The intent of the project is to collect data that would
579 ultimately support development of treatment targets for use of roof runoff. Despite targeting a
580 different type of alternative water source, the project's lessons could be conceivably extended
581 to a future reclaimed water citizen science initiative. Other examples related to agricultural and
582 water management are the On Drought project and the Citizen Observatory of Drought (EU-
583 citizen, 2023). Such participatory initiatives can be both valuable for increasing people's
584 acceptance of alternative water sources, and for supporting the development of treatment
585 targets and health standards for the safe use of such sources (the so called "policy uptake"
586 outcome, discussed in Berti Suman 2021). Especially in the wake of the new EU Water Reuse
587 Regulation, it can be imagined that local competent authorities will turn to citizen science
588 initiative to explore and foster human acceptance of non-conventional water sources in
589 agriculture.

590

591 **Conclusion**

592 This research presented a review of the current legislative and policy frameworks addressing
593 non-conventional water resources treatment and application in agriculture in selected
594 Mediterranean countries, linking literature review and stakeholders' opinions. This EU
595 legislative scene has been examined at a cross-national level and concerning EU and non-EU
596 countries.

597 The influence of the EU framework on non-EU countries, and vice versa, suggest that lessons
598 can be learned from a comparative analysis to tackle the common challenge of water scarcity
599 while guaranteeing food security. The non-EU countries targeted in this study showed more
600 advanced strategies in using non-conventional resources in terms of effectiveness and
601 convenience for agricultural purposes, which could help extend their best practices into the EU
602 context.

603 The legislative frameworks in each participating country are very diverse (in terms of the 'age'
604 of the provisions; implementation; users' perceptions) as different are the triggers and concerns
605 of the actors in the sector, yet some common trends have been found and illustrated with

606 concrete examples along the manuscript. Conceivable and reported factors enhancing or
607 hindering the successful implementation of the practice have been pinpointed, bearing in mind
608 the importance of context dependence, which inevitably will determine the success or failure
609 of an initiative.

610 At the EU level, a key barrier identified was the absence of common EU environmental/health
611 standards on the matter and the potential obstacles that could derive from the free movement
612 of agricultural products irrigated with reclaimed water. This could lead to increase scepticism
613 from the interested public (from experts to lay people). The new EU Water Reuse Regulation
614 has the characteristics to tackle this obstruction by bringing an integrated legislative instrument
615 setting minimum requirements for water reuse in agriculture. This Regulation can be
616 considered an important milestone toward creating a shared consensus on common standards
617 for non-conventional water use in the EU agricultural sector.

618 The analysed regulation contained measures to motivate efficiency, cost-savings and
619 innovation and streamline the process's governance. Stakeholders along the supply chain play
620 a key role in the functioning of this type of innovation, from the technical side to making it
621 happen to consumers willing to accept this water use. Therefore, stakeholders' consultation and
622 integration into decision-making could also be key to the success of non-conventional
623 resources water use.

624 An avenue to promote greater stakeholder engagement is to foster new and support existing
625 citizen science initiatives revolving around the matters of water scarcity, water reuse and in
626 general sustainable practices in agriculture. Civic initiatives developed within sectors of
627 interest, e.g., groups of farmers, could be useful to inform the policy and scientific debate on
628 how to best adapt to the new EU Regulation.

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635

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