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Reuse of treated waste water in the Mediterranean
and impacts on territories

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FOREWORD

The 8th World Water Forum will take place in Brasilia from 18 to 23 March 2018. The preparatory Mediterranean process managed by the Mediterranean Water Institute and the Union for the Mediterranean, is a unique opportunity to mobilise all the stakeholders and to make original propositions to ensure access to water and sanitation for all in the Mediterranean.

Appointed as coordinators of the working group on the "urban" topic, the Economic Foresight Institute for the Mediterranean World (IPEMED) and the Medcities network wished to take advantage of this process to highlight the know-how of cities and operators in terms of reuse of treated waste water (REUSE); as this topic was the main subject of the last United Nations report on the development of water resources.

Learning from past experiences, sharing and spreading information, taking into account the opinion of field actors... such are the objectives of this report, which was written in partnership with the Euromed Cities Network, the International Office for Water (IOWater) and the Euro-Mediterranean Information System on Know-How in the Water Sector (EMWIS). This approach is in keeping with the positions taken by the Mediterranean since the first Mediterranean Forums and during the last editions of the World Water Forum[1].

WATER CHALLENGES IN THE MEDITERRANEAN

According to the 2014 GLAAS report[2], although access to drinking water and sanitation is a human right, which was recognised in 2010 by the UN General Assembly, this right does not always appear in the national legislation of Southern and Eastern Mediterranean countries (SEMCs)[3]. Yet, some Mediterranean countries got good results regarding the percentage of their populations using an improved drinking water source or improved sanitary facilities (cf. Figure 1). The available data, especially in the framework of the Joint Monitoring Programme for Water Supply and Sanitation (JMP) carried out by the WHO and UNICEF, underline that the situation varies from one country to another, as well as within each country, between urban and rural populations. Indeed, it is estimated that 45 million people in the ANMO region[4] (16% of the total population) do not yet have proper access to drinking water, and 80 million do not have access to satisfactory sanitary facilities[5].

1 *Cf. The position paper of the Concluding Workshop of the Mediterranean Process entitled "Taking stock of Mediterranean strengths and the way forward" delivered on 1 April 2015: "Significant progress has been made through the expansion of the wastewater collection and treatment systems, resulting on the one hand in positive improvement of health conditions (safe urban and rural sanitation) and on the other hand on reduced pressures to marine ecosystems. Nonetheless, the nexus approach would require a re-consideration of the design of many of these systems for maximising the related benefits supported by awareness campaigns".*

2 UN-Water/OMS (2014), *Global Analysis and Assessment of Sanitation and Drinking-Water report.*

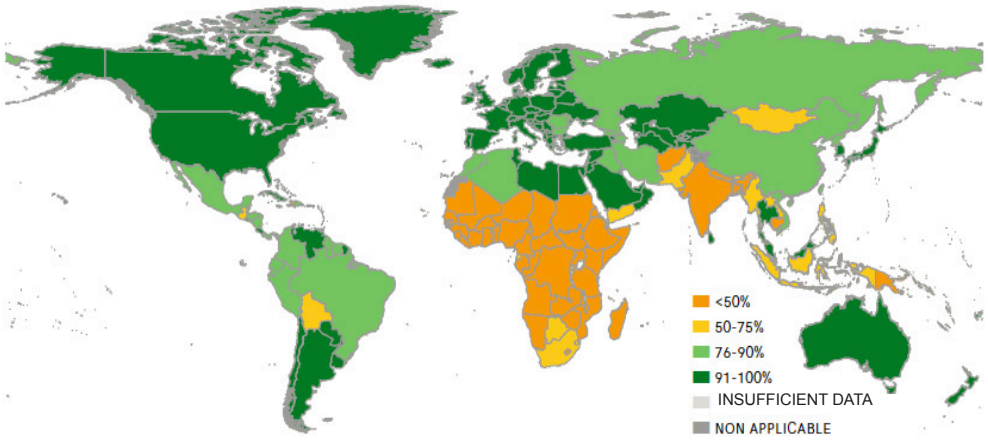
3 Includes Morocco, Algeria, Tunisia, Libya, Egypt, Israel, Jordan, Lebanon, Syria and Turkey.

4 The 6 North-African countries (Mauritania, Morocco, Algeria, Tunisia, Libya and Egypt) as well as the 15 Middle-Eastern countries (Syria, Lebanon, Palestine, Israel, Jordan, Iraq, Iran, Kuwait, Saudi Arabia, Bahrain, Qatar, United Arab Emirates, Oman, Yemen.

5 Al-Baz & al. (GIZ, 2016), *Integrated management of waste water in the Mediterranean - Good practices in terms of centralised and decentralised approaches in view of reusing waste water.*

The project of waste water treatment in Asselda (Morocco) provides clean water to inhabitants and orchards.

FIGURE 1 – Share of population having access to basic sanitation services in 2015



Source: WHO/UNICEF, *Progress in terms of water, sanitation and hygiene* (2017 update and SDG estimations), 2017, p.4.

The structural water stress situation in SEMCs, an increasing anthropogenic pressure and the expected impacts of climate change may be obstacles to the Sustainable Development Goals (SDGs), and especially the 6th objective, i.e. "Ensuring access to water and sanitation for all and ensuring the sustainable management of water resources". They may also hinder the resolutions of the Paris Agreement and of the Habitat III conference.

Indeed, the Mediterranean region only boasts 3% of fresh water resources and 1.2% of renewable natural water resources in the world. It hosts nearly 60% of the world's population that does not have much access to water, that is to say having access to less than 1,000 m³ of water/inhabitant/year. Besides, its water resources are mostly cross-border resources; 66% of surface waters in the Mediterranean come from outside the region. The available water resources in the ANMO region are already over-exploited, as shows the table below.

TABLE 1 - Share of population having access to basic sanitation services in 2015

COUNTRY	TOTAL POPULATION [1,000 inhabitants]	TOTAL RENEWABLE WATER RESOURCES (TARWR) PER PERSON [m³ inhabitant/year]	TOTAL WATER WITHDRAWAL IN PERCENTAGE OF THE TARWR	AGRICULTURAL WATER WITHDRAWAL IN PERCENTAGE OF THE TOTAL WATER WITHDRAWAL
ALGERIA	39,208	297,6	49,0 % (2001)	61,2 % (2001)
EGYPT	82,056	710,5	-	-
JORDAN	7,274	128,8	100,0 % (2005)	65,0 % (2005)
LEBANON	4,822	933,8	29,0 % (2007)	59,5 % (2005)
LIBYA	6,202	112,9	-	-
MOROCCO	33,008	878,6	36,0 % (2010)	87,8 % (2010)
PALESTINE	4,326	193,5	49,9 % (2005)	45,2 % (2005)
SYRIA	21,898	767,2	99,7 % (2005)	87,5 % (2005)
TUNISIA	10,997	419,7	61,7 % (2001)	76,0 % (2001)

Source : al-Baz & al. (GIZ, 2016), *Gestion intégrée des eaux usées dans le bassin méditerranéen. [Integrated management of waste water in the Mediterranean basin]*

An integrated approach of these challenges shows how the issues of water and sanitation threaten the other development objectives and have consequences on health, public hygiene, biodiversity, food, education and poverty eradication. The economic impacts due to lack of sanitation are also significant: for instance, Mauritania loses USD 41 million each year because of bad hygiene conditions, and this amount equates to USD 13.1 per person and per year in Mauritania, or 1.2% of GDP[6].

INTEGRATED URBAN WATER MANAGEMENT (IUWM) TO HELP MEDITERRANEAN CITIES AND TERRITORIES ADAPT

The demographic and urban growth in SEMCs as well as the development of agricultural and industrial productions are pressuring water resources. According to the United Nations' expectations, the population in SEMCs could reach over 360 million people in 2030, against 280 million currently. The urbanisation rate is significantly increasing. 2/3 of Mediterranean people live in urban areas and over 3/4 of them should do so in 2030. According to the Food and Agriculture Organisation of the United Nations (FAO), the domestic, commercial and industrial uses of water only account for 16 to 22% of water withdrawals in SEMCs. The rest is mostly monopolised for agricultural and environmental uses of water. Between 78 and 84% of fresh water resources in SEMCs are dedicated to agricultural productions[7] because of extended irrigation and the increase, since 1960, of water-consuming productions. Agriculture monopolises over 4/5 of the water available in Cyprus, Egypt, Greece, Libya, Morocco and Syria, 3/4 in Portugal, Tunisia and Turkey, and nearly 2/3 in Algeria, Spain, Lebanon and Jordan.

> The main challenge for Mediterranean cities is to improve the resilience of their current urban water management systems and of their sanitation networks.

According to the forecasts, the total water demand should increase by 50% between 2000 and 2030[8], mostly in cities, while the water availability per person will drop by half by 2050. The water availability should reach a threshold inferior to the "absolute shortage" level, at 460 m^3 per person and per year, by 2023[9]. Indeed, according to the intergovernmental group of experts on climate change, the Mediterranean regional climate change index is, along with that of North-Eastern Europe, the highest in the world. By 2100, the temperature in the region should increase by 2 to 4°C, the rainfall amounts should drop by 4 to 30% and the sea level should rise by 20 to 60 cm[10].

Therefore, the main challenge for Mediterranean cities is to improve the resilience of their current urban water management systems and of their sanitation networks. According the United Nations (2017), all these challenges can be opportunities to promote innovative approaches in terms of water management, and especially integrated urban water management. This approach regards waste water as a key element of the water cycle and as an alternative source of water, that can be used for agricultural, energy and industrial purposes in the circular economy.

6 *Water and Sanitation Program*, March 2012..
7 FAO AQUASTAT, chiffres de 2016.
8 ONU-Habitat, *World Cities Report,* Ch. 5.
9 Al-Baz & al. (GIZ, 2016). op cit.
10 Report of the intergovernmental group of experts on climate change (GIEC), 2007.

Reuse of treated waste water: what solutions in the Mediterranean?

Waste water, a resource that remains little exploited in the Mediterranean

In 2011, the volume of waste water produced in all the SEMCs was estimated at 8,134 km³ (Israel excluded)[11]. According to the World Bank, over the last twenty years, Mediterranean populations have had increasing access to improved sanitation, reaching nearly 91% for SEMCs in 2015, and 97% for Mediterranean European countries[12], well above the global average (67%). Nearly 63% of coastal towns of over 2,000 inhabitants in the Mediterranean basin were equipped with waste water treatment plants (WWTPs) in 2013[13], among which 67% carried out a secondary treatment and 18% only a primary treatment. However, away from coasts the connection to sanitation networks and WWTPs remains limited. Although major urban centres have sewage networks, septic tanks and open tanks remain common in the least developed countries in the region. Besides, all sewage water and run-off rain water are not necessarily collected, for lack of infrastructures, because of a significant leakage rate in the network, or because of illegal discharge of non-treated effluents.

It is difficult to have access to precise, up-to-date and harmonised data on the volume of produced waste water, the collection rate of waste water, or the treatment rate of waste water collected in countries of both shores of the Mediterranean[14]. According to estimations, the treatment rate depends on countries: while some reach levels that are similar to that of northern Mediterranean countries, like Israel (93%)[15] or Jordan (88%), and others have satisfying treatment levels, such as Egypt and Tunisia (79%), some countries are lagging behind, like Syria (40%), Morocco (20%), Libya (7%) and Lebanon (2%)[16]. In European countries, some States manage to treat all their urban sewage water[17], like Malta (99%), Spain (95%) and Greece (93%, a leader in terms of tertiary treatment). Some have satisfactory results, like France (80.5%), while others struggle to reach the objectives set by the European Commission, such as Italy and Portugal (60%)[18], having worse results than Turkey (64%).

This treated waste water is likely to be reused (REUSE), if the treatment is adapted to its use. Yet, apart from a few leader countries, all the Mediterranean countries took some time to understand the opportunities that derive from a generalised use of this unconventional water source. Thus, over all the Arab countries, only 23% of safely treated waste water was used in 2013, mostly for irrigation[19]. Israel and Jordan have a leading role in SEMCs, with a reuse rate of over 85% of their collected waste water. In Europe, Cyprus and Malta are the most advanced in terms of REUSE, with 90% and 60% of their treated waste water reused, way ahead of other States (about 2.4%[20] in average in Europe) and ahead of France, that only reuses 0.2% of its waste water[21].

Although most Mediterranean countries have understood the reuse potential of treated waste water and started implementing the REUSE, the share of reused waste water in the region remains low, in spite of the various applications that are made globally, be they direct (watering and irrigation, industrial cooling) or indirect (discharge in a recipient source, such as an aquifer or a river).

11 Figures taken from the report *Water reuse in the Arab world,* (2011).

12 Including Portugal, Spain, France, Italy, Malta, Greece and Cyprus. World Bank figures, https://donnees.banquemondiale.org/indicateur/SH.STA.BASS.ZS

13 NGO Grid-Arendal figures, www.grida.no/resources/5908

14 For an explanation on methodological difficulties, see the Joint Report AEE-PNUE/PAM, *Rapport Horizon 2020 sur la Méditerranée - Vers des systèmes d'information partagés sur l'environnement*, *[2020 Report on the Mediterranean - Towards shared information systems on the environment*], 2014, p.79.

15 Israel Water Authority, 2015.

16 Figures taken from al-Baz & al. (GIZ, 2016), op. cit. The treatment rate corresponds to the percentage of waste water in collected volume. Estimations based on the following sources: Jeuland 2011, using data from the Aquastat database (FAO 2010), Kfouri & al. (2009), Jimenez et Asano (2008), Global Water Intelligence 2010 (www.globalwaterintel.com), and reports by countries drawn up by the joint programme of the World Health Organisation and UNICEF (2010). Other national sources can provide different estimations: in Morocco for instance, the treatment rate of waste water at the end of 2015 was of 48% without outfalls discharging into the sea, and of 61% with these outfalls, according to the study on the Programme National d'Assainissement Liquide et d'épuration des eaux usées : Bilan d'Etape et perspectives [National programme of liquid sanitation and waste water treatment: achievements and prospects].

17 Municipal waste water comes from domestic, industrial, commercial and institutional sources in a given urban community or establishment. Urban waste water includes municipal waste water as well as urban run-off rain water.

18 European Environment Agency figures, 2015. All treatments included.

19 UN (2017), *"Wastewater: an untapped resource", Global report of the United Nations on the use of water resources 2017.*

20 European Commission figures.

21 Figures of the International Office for Water.

Vitalising the local economic environment through the reuse of treated waste water

A REUSE PROJECT ALWAYS TAKES PART in the economic development of the territory in which it is implemented, from the construction of the necessary infrastructures to the use of the treated waste water.

A reuse project requires the construction of an WWTP or a treatment process equipped with technologies that enable a secondary and even a tertiary treatment of waste water, and sometimes a sanitation network that connects the WWTP to various points of waste water production. According to the technology level required, local entrepreneurs can take part in the construction of the infrastructures, especially in the case of a decentralised WWTP, with or without local network and "natural" technologies. The REUSE project becomes an element of territorial ecology. In Ait Idir[22], a village of the Anti-Atlas, in Morocco, a Moroccan research office and a local construction company built small independent units equipped with technologies enabling effluents' methanisation. The interest in the project reached other peri-urban and rural communities, that showed their enthusiasm for these decentralised sanitation techniques, thus giving the construction sector development opportunities that, in the medium-term, could lead to the creation of specialised companies.

The maintenance of WWTPs and their potential networks require the hiring of staff with various qualification levels, according to the complexity of the facility and of the processes. In Zarqa (Jordan), many young people found a job thanks to the construction of the water treatment plant of As-Samra, one of the largest plants in SEMCs, that treats the waste water of Amman and Zarqa governorates (about 3.5 million people). According to the French Development Agency, 32,500 people were employed directly and indirectly through the Jordanian REUSE project[23].

Once the infrastructures are built, the WWTP can start producing treated waste water that is adapted to the intended use. The water coming from the REUSE can be sold at a lower price than that of the m³ of drinking water in order to boost the economic fabric, and thus reduce users' bills[24]. Several sectors could be interested in these cheaper water resources:

- **Agriculture** is the most water-intensive activity at the Mediterranean scale, and the unplanned reuse of waste water is often perpetrated by farmers who try to save money, but who jeopardise their business and their health. Farmers can therefore be interested in this type of water, provided that its quality is reliable. As-Samra, for instance, produces treated waste water for 4,000 farms.
- **The industries** that consume a lot of water for cooling or production processes: for instance, three projects of industrial reuse of treated waste water for phosphate-washing were carried out in Morocco since 2010, 2015 and 2017 and are now operational.
- **Townships** themselves could use it to reduce their costs in terms of public road cleaning, vehicle fleet cleaning, watering of green spaces or water provision of facilities (fountains, artificial snow generator, etc.).
- **Individuals** could use it for activities that do not require fresh water (watering, exterior cleaning, etc.).

Committed into a REUSE approach since the 1970's, the Gran Canaria island[25], in Spain, resorts to treated waste water for irrigation. This approach enabled to maintain the competitiveness of farms that grow water-intensive produces while the price of drinking water is very high, owing to the scarce water resources, the significant tourism activity and the cost of sea water desalination. In Granollers[26], following the implementation of a REUSE project in 2002, the town is thinking about selling the waste water treated by the WWTP, which is located in an industrial area near an artificial wetland, to local companies, in order to boost the economic attractiveness.

22 Al-baz & al. (GIZ, 2016) op. cit.

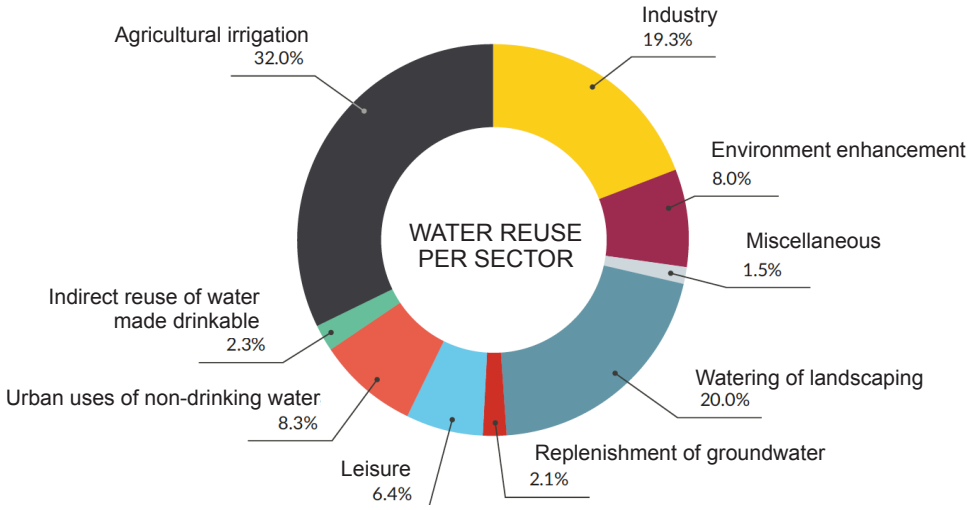
23 AFD (2011), Reuse of treated waste water (REUT), methodology elements for projects' instruction. Figures of the research office BRLi.

24 One point should be further discussed: the economic value of the treated water and the pricing of the treated waste water. Given that in some countries the water price includes the collection, the treatment and the discharge in the environment, who owns the treated water if it is bought by third parties to be sold again?

25 European Commission (2007), *Report of the MED-EUWI Wastewater Reuse Working Group*.

26 Case study that was presented at the round table on the urban topic: "Reuse of treated waste water in the Mediterranean and its impacts on territories", co-organised by IPEMED and Medcités during the 3rd Mediterranean Water Forum, in Cairo, on 23 January 2018.

FIGURE 2 – Sectors in which (tertiary) treated waste water can be reused



Source : Lautze & al. (2014, fig. 2, p. 5, figures taken from the Global Water Intelligence).

For a circular economy of water: an ecological approach that protects water resources and ecosystems

For countries in a major water stress situation like SEMCs, and more generally Mediterranean countries, replacing conventional water resources by REUSE water for uses that do not require high-quality water enables to preserve the available water resources and to increase the global available water resources.

In Agde[27], a French sea resort along the Mediterranean coast, the town financed the modernisation of the WWTP, with the support of the Agence de l'Eau Rhône-Méditerranée-Corse. Thanks to the installation of a tertiary treatment system by membrane filtration, the town can meet the needs generated by the demographic growth and water its green spaces, especially the municipal golf. By withdrawing less water, the town is making substantial savings: The use of treated waste water and the monitoring policy of the drinking water network implemented by the municipality will enable to reduce the town's drinking water consumption by 600,000 m³ per year, that is the consumption of over 10,000 inhabitants.

Besides, the REUSE approach contributes to two SDG targets on water and sanitation:

- The 6.3 target: "*by 2030, improve water quality by reducing pollution, [...] halving the proportion of untreated waste water and substantially increasing recycling and safe reuse globally*".
- The 6.6 target: "*by 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes*".

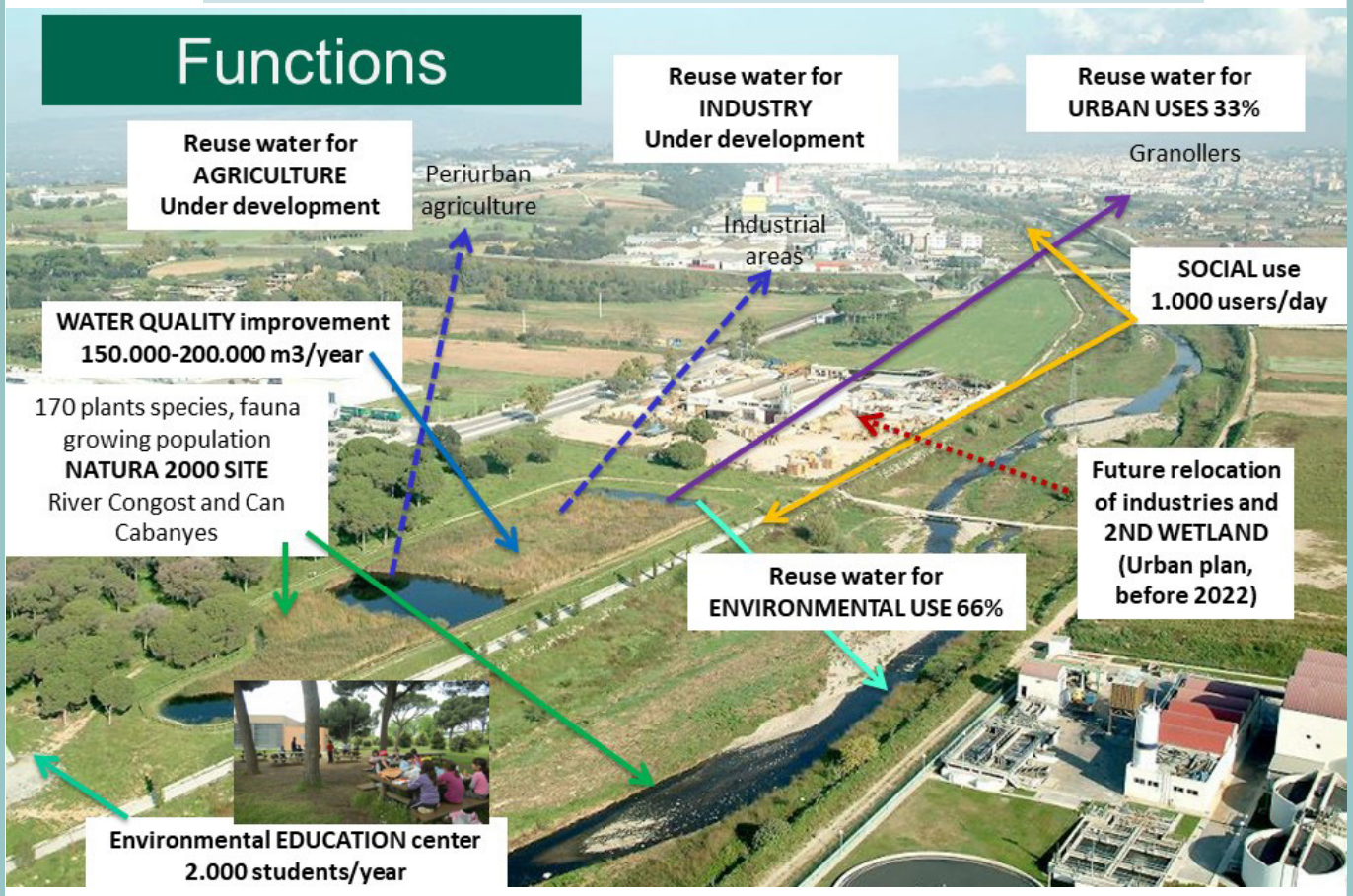
The waste water having undergone a tertiary treatment is also likely to be reused indirectly for the replenishment of underground water resources, rivers, ponds or lakes, or for the replenishment of a wetland to prevent desertification. Combined with fresh water, this treated waste water resumes a natural cycle, is filtered by grounds and rocks, enriched in minerals and, later, may be considered as fresh water, that could be treated to become drinkable.

Waste water that underwent a tertiary treatment can also contribute to reducing the pollution of conventional water sources: the discharge of treated waste water into rivers and groundwater can reduce the content of nutriments, salt or other toxic pollutants in fresh water sources and help protect sensitive hydraulic entities. Treated waste water can thus serve as an anti-salt barrier if it is discharged into coastal aquifers. The WWTP of Baix-Llobregat in the Barcelona suburbs, in Spain, separates the treated waste water dedicated to irrigation from that which will be discharged into groundwater. The latter undergo a treatment that combines microfiltration and the reverse osmosis process in order to remove all salt from the water and thus reduce the water salinity of coastal groundwater.

27 Idem

Through the reinstatement of rivers and wetlands, or the improved quality of the sea water into which it is discharged, the treated waste water from the REUSE can protect ecosystems: in Granollers, a former industrial city, the municipality launched - with the support of the European Commission Cohesion Fund - the environmental refurbishment of an industrial wasteland, Can Cabanyes, located near the local WWTP, and crossed by the city's river, the Congost. This project, that was initiated in 2002, combined the environmental conversion of a wasteland to create a green space in the industrial area, and a REUSE project through the creation of a one-hectare wetland, ensuring the tertiary treatment of waste water. Certified "Natura 2000" in 2006, Can Cabanyes became an attractive area thanks to the town's environmental policy. Discharging part of the treated waste water into the Congost and creating a wetland regenerated the local biodiversity. The ecological space has an environmental awareness centre for young people as well as an ornithological observatory; it welcomes nearly 400 people every day.

FIGURE 3 – Schematic presentation of the project carried out by Granollers



Source : with the authorization of Xavier Romero.

Finally, developing a REUSE project that preserves nature and water resources enables to reduce the human environmental footprint, whether it is to reduce withdrawals, to restore natural environments or to fight against pollution. It is a strategy to minimise and adapt to the effects of climate change, and it contributes to reinforce the resilience of urban communities and their territories in the face of climate change.

The challenges of implementing a REUSE project

Why it is necessary to plan a REUSE project

One of the main difficulties in the reuse of treated waste water is to "*shift from an informal and unplanned use of partially treated or non-treated waste water, to a safe and planned practice*"[28]. To do so, waste water management should be planned ahead, by taking into account the various WWTPs that waste water goes through, from the pollution source to the final use. By understanding local specificities, and especially the needs generated by the context (socio-economical, environmental, sanitary...), we can apply the principle of water reuse that is "adapted to the intended use". This means that the required level of treatment is determined by the water quality level required for the intended use. This water quality level is, generally speaking, defined in the health security guidelines provided by the law or the relevant governmental authorities. In most cases, a secondary treatment is enough. Most uses no not require drinking water, and therefore the water quality level can be inferior. However, there are still obstacles preventing a massive implementation of this approach, and especially the inappropriate national frameworks. These standards and regulations are sometimes too strict to be feasible, and they can't always be applied to existing practices of treated waste water reuse[29].

Yet, most of the environmental risks of the REUSE are linked to the wrong treatment of waste water compared with the use that is made of it. The presence of toxic products in treated waste water makes it dangerous for health and the environment[30], thus creating an insidious pollution that needs to be eliminated during the treatment of waste water. This pollution can eventually contaminate grounds, fauna and flora, and especially agricultural products. It surrounds the water source in question, thus threatening the ecosystem and the health of people who live near this area or who eat the locally-grown produces[31].

Before the construction of the As-Samra WWTP, the former plant, located near the river, produced on several occasions bad-quality treated waste water, which contaminated the water reserves dedicated to irrigation, as well as the Zarqa river. The authorities where then forced to forbid the sale of agricultural produces irrigated by reused waste water as well as the irrigation basin water that partly came from the WWTP.

In order to counter this bad treatment involving a pollution or sanitary risk, it is necessary to reinforce the projects' follow-up and monitoring capacities. The multi-barrier approach, implemented in Jordan, is one of the methods to prevent some sanitary and environmental risks through hygiene control measures. This approach, elaborated by the WHO[32], includes controls and risk assessments throughout the food chain. It aims to reduce the risks by making each control an independent one, thus ensuring the withdrawal of a product in case of non-conformity at some point of the process.

Agricultural irrigation in Jordan

28 UN, p 127.

29 Al-baz & al. (GIZ, 2016), op cit.

30 UN, op cit.

31 Al-baz & al. (GIZ, 2016), op cit.

32 WHO (2006a), WHO Guidelines for the safe use of wastewater, excreta and greywater in agriculture.

Favouring the reuse of treated waste water through a better access to funding

The 6.2 SDG encourages States to "*ensure access to adapted sanitation and hygiene services for all, in fair conditions*" by 2030. Although, in Europe, almost all citizens have been benefiting from sanitation for years, SEMCs bridged part of this gap over the last ten years thanks to an ambitious investment logic to strengthen their capacities. However, the REUSE approach, that is promoted in target 6.3, remains insufficient in most cases because of the lack of dedicated infrastructures, due to a lack of funds.

Indeed, the implementation of a REUSE project involves the use of infrastructures to collect and convey waste water, of a WWTP with secondary treatment processes and, depending on the intended use, of a tertiary treatment, but also sometimes of a conveyance network of treated waste water towards its place of use. In Northern Mediterranean countries, conveyance networks of waste water and WWTP often exist before the REUSE project. However, it is not always the case in SEMCs, and especially in medium-sized towns, rural villages or some metropolis neighbourhoods, like in some districts of Amman, in Jordan. The construction of a WWTP, with the adapted equipment and infrastructures, is much more expensive than the construction of a treatment plant to make water drinkable, and it can be prohibitive for municipalities without the support of the State, which is the first financer of this type of projects. In Agde for instance, the municipality solicited the State with the help of the Rhône-Méditerranée-Corse (RMC) Water Agency, a public organisation of the Ministry of Sustainable Development, in order to get an expertise for the project implementation, as well as a 80% funding assistance of € 5.5 million for the WWTP works. The RMC Agency then announced that all the WWTPs modernisation projects of dependent municipalities in its action zone had to integrate innovative processes (REUSE, reuse of sewage sludge, energy production, etc.).

Public-private partnerships (PPPs) can be an adapted solution for the implementation of REUSE projects.

However, States are not always able to support all or part of the projects. In this case, several solutions exist through the private sector:

- **Bank loans**, easier to achieve in Northern Mediterranean countries, can help when part of the capital is missing. According to the project's management, the cost of interests can be paid by the final users of treated waste water.
- **Public-private partnerships (PPPs)** can be a solution in several cases: for the construction and operation of "centralised" WWTPs, that require a significant technical and financial support, like the As-Samra WWTP, that was built according to the Build-Operate-Transfer (BOT) model over 25 years; for local and targeted projects, where an industrialist wants to reuse waste water for his own activity, such as the Office Chérifien des Phosphates, in Morocco. The OCP financed 3 projects of waste water reuse and treatment operated by the Office National de l'Electricité et de l'Eau Potable (ONEE) to save up on phosphate washing, a process that requires significant amounts of water. Although PPPs are developing, they remain marginal in medium-sized towns and almost non-existent in peri-urban and rural areas, especially in SEMCs..

Another way to finance REUSE projects, especially for SEMCs, is to resort to international organisations and to cooperation. The 6a target of SDGs encourages States to "*expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting,* [...], *water efficiency, wastewater treatment, recycling and reuse technologies*". This logic, that relates sanitation and the REUSE, is generally carried out in two ways:

- **Public-public partnerships (PUP)**, often organised in the framework of decentralised cooperation, enable two public entities, sometimes from two different countries, to work together on a financing programme aiming to reinforce the capacities of the assisted partner. For example, the municipality of Agde works with the town of Tata, in the Souss-Massa region, in Morocco, on water management. By using the 1% mechanism of the Oudin-Santini Law (2006), Agde, supported by the RMC Water Agency, contributes to liquid sanitation works and to the future extension of the WWTP for the tertiary treatment. The cost of the project amounts to € 4.5 million, 31% of which are cofunded by the AERMC and Agde. Beyond offering decent living conditions to inhabitants, the objective is to create a green belt around the locality of Anti-Atlas, while significantly saving drinking water in this mostly agricultural region and reducing pollution to make the region more attractive for tourists.

- **International sponsors**, be they national development agencies (AFD, GIZ, USAID), international institutions (World Bank, UNDP) or NGOs working in the water and development fields (PSeau, RIOB) that can, when Southern municipalities take part in their calls for projects, participate to the funding of the WWTP or treatment processes that are specific to the REUSE.

Cooperation must be strengthened and better managed at the regional level, by creating synergies between the strategies carried out by Trans-Mediterranean institutions (UNEP/MAP, 5+5 Dialogue, Union for the Mediterranean) and the projects carried out by other organisations, such as non-governmental organisations. This role could be endorsed by a Mediterranean Water Agency[33]. In the short term, the UfM, with the support of international financial institutions and development agencies, should launch a Trans-Mediterranean call for projects that enables to target innovative scientific or normative projects, required by many actors in the region, in order to promote this approach and develop experiences.

The UfM, with the support of international financial institutions and development agencies, should launch a Trans-Mediterranean call for projects that enables to target innovative scientific or normative projects.

33 Cf. Fadi Comair, Jean-François Donzier, Hervé Lainé, Eric Mino (2010), *A Mediterranean Water Agency to move from strategy to action*, IPEMED.

Building of a new waste water treatment plant of 270,000 m3/day. Oran, Algeria.

Sustaining the reuse of treated waste water

One of the major issues linked to the REUSE remains the financial viability of the operation. Even though the capital necessary to build infrastructures is available, the maintenance cost of treatment processes and network remains. Indeed, the cleaning-up and treatment of waste water are much more complicated and expensive than the production and conveyance of drinking water. Recycling waste water only becomes economically viable when the cost is paid off through its commercialisation. To do so, the treated waste water must reach a sufficient quality level to be reused. Commercialising treated waste water, very often at competitive prices, is rarely enough to recover the totality of operating costs. In some situations, the managing organisation has to support extra costs that only the State can finance. In SEMCs, these costs of operation and maintenance of sanitation infrastructures are often covered by government grants[34]. So that most water reuse project rely on grants that are financed by taxes. For Northern Mediterranean countries, although the cost of waste water treatment for reuse is included in the general sanitation royalty (especially for PPPs), and even in the drinking water service billing, few projects benefit from financial autonomy.

To make projects viable, other innovative pricing or recycling processes enable to better tackle this essential issue:

A SECTORAL PRICING OF TREATED WASTE WATER

This pricing method consists in increasing the m^3 price according to the user. A rather high price for the m^3 of reusable treated water can hardly be applied to the agricultural sector, as States heavily subsidise irrigation. However, a higher pricing can be applied to other, financially independent sectors, such as the industrial sector, and even private users, but this approach may discourage users to use treated waste water if its price is no longer competitive with the price of fresh water.

THE ECONOMIC VALUATION OF THE NATURAL CAPITAL REPLENISHMENT

Relying on shared benefits, this system can work when the company/public service in charge of drinking water pays part of its benefits to the company/public service in charge of wastewater treatment to replenish groundwater with good quality waste water, thus contributing to increase the available resources.

VALUE-CREATION ON THE TREATMENT SITE

This strategy aims to increase the number of activities by using resources coming from waste water, or by using treatment sub-products.

In the first case, waste water can be directly used, provided that it is in an adapted environment, to grow micro-algae and duckweed. These vegetables can then be sold as food for fish breeding or processed to produce biofuel.

In the second case, many sub-products can be used:

- **Sewage sludge** can generally serve as nutriments to make fertilizers. They can also serve as construction materials once they are processed and dried. This technique belongs to the integrated management strategy for sanitation waste of Agua de Portugal. However, in all Mediterranean countries reusing sewage sludge is difficult for lack of regional or international norms. States must therefore choose what to do with this waste, and they often opt for landfills. The European Commission, which is currently working on new discharging norms, will not be able to provide regulations on sludge so long as its member States have not agreed on the topic..
- he REUSE requires a significant amount of energy, however it is possible to reduce this high demand by **using treated waste water as a source of energy** (waterpower, thermal energy and biogas), although they remain little used so far. The electricity produced can be used by the WWTPs or be sold to an energy company in order to pay off the water treatment costs.

34 WHO (2014a).

In As-Samra, the greatest WWTP in Jordan that treats the waste water of the Amman metropolis, between 80% and 95% of its electrical needs are balanced by the production of two sources of energy: waterpower thanks to upstream turbines and downstream treatment basins, and biogas production via digesters.

In total, the WWTP produces 75 GW/year, part of which supplies the Jordanian capital. On the other hand, the municipality of Agde is planning to heat part of its buildings thanks to the thermal energy generated by the treatment of waste water in its WWTP.

- Thanks to the metals and other inorganic elements present in waste water, especially in industrial effluents, not only is it possible **to collect high-added-value sub-products**, but also to reduce the health problems and environmental pollution created by their discharge. Effluents from extractive and electric industries can contain traces of heavy metals (gold, silver, nickel, palladium, platinum, cadmium, copper, zinc, molybdenum, boron, etc.), while waste water contains phosphorus, a material which global reserves are going to fade within 50 to 100 years. According to the UN, with the appropriate technologies, 22% of global consumption could be produced via the treatment of faeces and urines contained in waste water[35]. Several extraction processes exist, with different levels of pollution and energy consumption, but these methods are not sufficiently developed yet to be used in the short term.

35 UN (2017) "Wastewater: an untapped resource"

Located in the middle of the desert, a few kilometres away from Amman, the capital, the new As-Samra plant must treat the waste water of 2.2 million inhabitants, and meet the needs of agricultural and industrial businesses in the region.

Source: SUEZ.

What governance for the REUSE in the Mediterranean?

For ambitious water policies favouring the reuse of waste water

Although REUSE has only just begun in most Mediterranean countries, many States gave REUSE a legal framework. In Europe, the European Commission integrated this practice into its water policy, but the exact definition of potential uses still depends on States that, for some, remain hesitant on the expansion of this process. In SEMCs, some States wrote laws very early in favour on the REUSE, but some legal and normative frameworks are now obsolete, or at least inadequate as regards environmental, sanitary and economic realities. Besides, the WWTPs that were built are quickly overcome by the needs, because of demographic growth as well as the operation costs and investments that are necessary to the smooth operation of infrastructures.

At the European scale, the European Commission recognises that the lack of information regarding the potential benefits of treating waste water is, for lack of an incentive and standardised legal framework, an obstacle to the development of this practice in the Union. Indeed, Spain and Greece authorise, in their respective legislations, many ways of using treated waste water; the Spanish legal framework (2007) being closer to the Californian and Australian ones, that are considered as the most detailed. However, most other countries limit the reuse to agricultural irrigation and green spaces watering, and forbid reuse for the industrial sector. It is the case of France, in the last order that was passed on the use of water coming from treated urban waste water for culture and green spaces irrigation (2014). To reinforce information and legal standardisation, the European Commission has launched, over the last few years, several initiatives[36]: an Action Plan to preserve European water resources in 2012[37], a Public Consultation on water reuse in Europe in 2014, an Action Plan in favour of the circular economy in 2015[38], etc.

In April 2017, the European Commission and fourteen partners signed the first "innovation agreement for a circular economy", regarding the sustainable treatment and the reuse of water. The Commission is currently working on a legal proposition regarding water reuse, with the objective of enforcing it before 2020.

On the other shore of the Mediterranean, 11 of the 22 Arab States took legislative measures in favour of the REUSE. In 2011, the Council of the Arab Ministers of Water adopted a strategy and an action plan on water conveyance safety, in which treated waste water was recommended as an unconventional water resource that could balance the water deficit of Arab countries. These initiatives launched a modernisation movement of legal frameworks in several countries. Yet, we must be careful to the means allocated to the REUSE policies and, more generally, to sanitation issues. We often note that the practices described in political intentions and regulatory instructions greatly differ from what is actually implemented on the field.

- **Tunisia** was one of the first Arab countries to contemplate the reuse of waste water. The law n°16-75 of 31 March 1975, enacting the "Water Code" already planned the use of waste water in agriculture, after "*an adapted treatment of this waste water in a wastewater treatment plant and upon decision of the Minister of Agriculture, with the agreement of the Minister of Public Health*" (Article 106). However, this Tunisian "Water Code" sets very strict quality standards, and some of them are not adapted to reusable treated waste water for irrigation and discharge into the natural environment (wadis, groundwater)[39]. Besides, the water quality controls required by the Tunisian State are too demanding regarding the actual capacities of existing operators and institutions, which leads to a lack of transparency and control unreliability. According to Mohamed Lotfi Dhaouadi, Director at ONAS[40], quoted by the Tunisian press, "*the problem does not lie in the quality of treated water, nor in the analyses of the Office, it lies in the ONAS waste water treatment plants that suffer*

36 http://ec.europa.eu/environment/water/reuse.htm

37 http://eur-lex.europa.eu/legal-content/EN-FR/TXT/?uri=CELEX:52012DC0673&from=EN

38 Communication of the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, "An EU action plan for the Circular Economy. Closing the loop", Brussels, COM (2015) 614 final, 2 December 2015.

39 Al-Baz I. & al. (GIZ, 2016).

40 Office National de l'Assainissement [National Sanitation Office].

from structural issues, in addition to the cost of a more advanced treatment. According to him, it is not possible to properly assess the quality of waste water, because the standard that rules treated waste water is itself very old (it dates back to 1989)[41]".

Because of this quality and transparency issue, many farmers refuse to use treated waste water. The Tunisian State is now trying to reinforce coordination and to adopt demand-based practices in order to improve the planning of waste water collection, as well as irrigation projects via safely treated effluents.

- **Morocco** is lagging behind in terms of infrastructures, especially in small towns, as well as peri-urban and rural areas. Nevertheless, significant progress has been made over the last few years regarding waste water cleaning-up and reuse, thanks to a proactive policy of the State via the ONEE[42]. The law n°36-15 on water was passed on 10 August 2016 and dedicates a whole chapter (chapter 5) to the use of unconventional water; of which 8 articles to the reuse of waste water and sewage sludge[43]. Article 70, for instance, makes it compulsory to treat sewage sludge from waste water; however the modalities will need to be set through regulations. This new law sets the regulatory foundations for the REUSE in Morocco; an issue that appeared as soon as 2008 in the National Water Strategy[44]. Moroccan public authorities are also working on the creation of a new shared programme, that integrates in particular the Programme National d'Assainissement Liquide et d'Epuration des Eaux Usées (PNA) [National Sewage and Wastewater Treatment Programme] implemented in 2006, the Programme National d'Assainissement Rural (PNAR) [National Sewage Programme for Rural Areas] and the Programme National de Réutilisation des Eaux Usées Traitées (PNREUS) [National Programme for the Reuse of Waste Water].

- **Jordan** is probably one of the best examples in terms of treated waste water reuse policy. Indeed, this practice was integrated into national water programmes ("Water for life" 2008-2022, National Water Strategy 2016-2025), by focusing on reusing treated waste water for irrigation and on recycling industrial waste water. To support these efforts, regulations on the reuse of waste water were adopted. The law requires that all new waste water treatment projects include sustainability aspects of water reuse, and highlights the necessity to build decentralised WWTPs for semi-urban and rural communities, and to replenish groundwater in a country where the water stress is one of the highest in the world. Public waste water is managed by a specific authority (the "Water Authority of Jordan") that delivers to private WWTPs the authorisation to discharge water in public sewage systems and in natural environments. The WAJ also carries out routine WWTP controls to make sure they meet quality standards.

> It is essential to involve local communities, from the beginning, into the governance of REUSE projects to guarantee the success and sustainability of initiatives.

Here the Moroccan and Jordanian examples show that to efficiently develop the recycling of waste water, it is necessary to include waste water management into the global Integrated Water Resources Management (IWRM), at the local and national scales. The framework must be pragmatic and flexible in order to embrace all the potential uses. Even though water management capacities go beyond municipalities, it is essential to involve local communities, from the beginning, into the governance of REUSE projects to guarantee the success and sustainability of initiatives.

In a logic of extensive water reuse, the future European regulations should include sewage sludge management. This progress would enable to link waste water management, its reuse as well as the management of waste resulting from the treatment (that can produce energy and fertilizers), thus creating a nexus logic water-energy-agriculture.

41 « Les eaux usées traitées destinées à l'irrigation : l'alternative ratée », [Treated waste water dedicated to irrigation: a missed alternative], Agence Tunis Afrique Presse, 04/11/2016 .

42 Office National de l'Electricité et de l'Eau potable [National Office of Electricity and Drinking Water] in charge of sanitation.

43 http://www.water.gov.ma/wp-content/uploads/2016/01/Loi_sur_leau_BO_Fr.pdf

44 http://www.environnement.gov.ma/PDFs/EAU/STRATEGIE_EAU.pdf

Anchoring the REUSE into a territory: Reinforcing the link between cities and their suburbs, including peri-urban and rural areas

When implementing a REUSE project, it is necessary to think about the relevant space in which it is implemented. Very often, in urban centres, large water treatment plants were built. Even though they enable to make economies of scale, they are costly, their construction is slow, and they are hardly adaptable to various socioeconomic situations, therefore they do not always meet territorial challenges. This is the case of peri-urban spaces, which grow with populations' urbanisation in SEMCs. Resorting to REUSE can recreate a link between cities and their territories via the treatment of waste water. Great volumes of urban waste water can be used to irrigate agricultural land. The REUSE also contributes to reducing the ecological footprint of urban centres by reducing fresh water withdrawals. Indeed, treated waste water can be used when high-quality water is not required, or to replenish groundwater.

The success of the Can Cabanyes project, in Granollers, is a great example of bond between a town and its territory. Following the success of the REUSE project that involved the creation of an artificial wetland on an industrial wasteland, the project was included into the inter-communal planning of territory use, through the creation of a "green belt" that contributes to preserve plant biodiversity (replenishment of wooden areas, pollution reduction in the Congost river) and animal biodiversity, while creating an ecotourism loop[45].

Centralising sanitation is not always possible in small towns or rural villages. Therefore, a significant share of the population remains without access to improved sanitation in rural areas, especially in SEMCs. According to the GLAAS[46] report, most funds provided by public authorities are dedicated to drinking water provision in the urban sector, even though the rural sanitation service is rather poor. Therefore, populations often have to resort to septic tanks (and sometimes open tanks), or to collection networks without waste water treatment, which present significant sanitary, economic and environmental risks for municipalities and their surrounding territories, not to mention the unplanned reuse of waste water by farmers.

A solution to this issue could be to build decentralised sanitation infrastructures. This alternative often includes a treated waste water reuse process for irrigation or biogas production, according to local needs. Operating with a network of variable size, these decentralised WWTPs can benefit from the space that is available in peri-urban and rural areas to use "extensive" and natural processes, such as lagooning. These technologies are ecological, sustainable, easy to access, and do not require extensive maintenance like that used in large sanitation plants. A stronger decentralised sanitation policy, focusing on natural technologies, could reinforce the capacities of countries that are lagging behind in peri-urban and rural zones. Yet, some States like Morocco or Egypt hinder the development of this type of projects with a regulation that is similar to that applied to centralised WWTPs, even though they say that they are favourable to this logic. Besides, without the support of public authorities, few municipalities can finance this type of projects. This is all the more so difficult in States like Morocco, where rural sanitation does not depend on a national agency, but on local independent public companies, or on citizen associations and groups, that sometimes have a contract with a public or private operator.

Al-Gozayyera[47], a small hamlet in the Nile delta, is a typical example. The local economy revolved around the agricultural sector, that had difficulties with the irrigation water coming from bad quality drainage channels. Indeed, water was contaminated because there were no sanitation systems apart from sceptic tanks and open tank to discharge their waste water. Each household had to pay a significant sum for the monthly sewage truck. The SWIM Sustain Water Med programme financed the installation of an innovative decentralised WWTP, based on the concept of a prefabricated unit equipped with an aerobic-anoxic basin. There are two objectives: on the one hand, treating the village's waste water effluents, and on the other hand, getting better quality water for irrigation by discharging the WWTP effluents into the drainage channels and thus improving soils fertility and quality.

45 Del Re N., Penna E., Romero Hidalgo X. (Ajuntament de Granollers - 2017), *Can Cabanyes as a green infrastructure for local economy: the ecological and social restoration of the Area.*

46 UN-Water/WHO (2014), GLAAS.

47 Al-Baz I. & al. (GIZ, 2016).

Making the REUSE more accessible: coordinating actors, promoting transparency, involving the civil society

Beyond technical processes and funding issues, a REUSE project depends on the good organisation of its actors, and on its social acceptance by the potential users of treated waste water. It is essential that users accept REUSE projects, if only to ensure the service pricing. The synergy between communities, businesses, scientists and associations of the civil society is also useful to define acceptance thresholds according to users.

One of the main recurring problems in the management of a REUSE project is the poor coordination between the project's actors (local and national public authorities, organisation in charge of sanitation, provider of treated waste water, quality-control organisation, user group, etc.). In some States, like in Egypt, the REUSE is attached to 3 Ministries depending on its use. In Tunisia, allocation differences exist between the distribution organisation, the waste water treatment organisation and users.

The capacities of local authorities should be reinforced, especially to implement the integrated management of water resources. As outlined in the UN report, there are several integrated and intersectoral approaches to manage water and land (upstream-downstream dynamic, urban water resources, etc.) that can bring innovative solutions and help actors converge towards common interests[48]. Besides, the 6b target of SDG encourages States to "*support and strengthen the participation of local communities in improving water and sanitation management*". The REUSE can also be a "bottom-up" initiative where local populations, according to their needs, encourage the authorities to find a solution via the REUSE.

The other solution to promote the REUSE approach is to strengthen its social acceptance, both with direct users and the civil society, especially when a project involves the reuse of waste water to replenish groundwater that is used to produce drinking water. Indeed, waste water reuse is often perceived in a negative way, with clichés directly associating toilet water and tap water (drinkable or not). It is therefore necessary to communicate on the REUSE, especially by informing users and populations. In this regard, a three-part approach "awareness-explanation-proof" should be developed:

- **Raising users' awareness** on the necessity to save water, by presenting water recycling as a sustainable solution. Raising awareness on water scarcity in some areas (coasts, metropolises, some rural areas) is the only way to make people accept the REUSE, to solve the waste paradigm: an increased consumption thanks to lower prices.
- **Developing explanations** on water treatment by showing quality differences and their effects, especially when they have a direct impact on people (bathing water for instance). At the same time, strengthening transparency over water quality controls by creating, for instance, alert systems for farmers in case of treatment default.
- Finally, **providing proofs** by sharing various national and regional experiences, positive and negative, of REUSE projects

48 UN (2017) "Wastewater: an untapped resource".

Waste water treatment plant of Gabal el-Asfar in Egypt.

Recommendations

- **BETTER ANTICIPATING:** Adapting the IWRM in a prospective manner to the coming challenges of climate change, urbanisation and demographic growth.

- **BETTER UNDERSTANDING:** Strengthening knowledge in the sanitation field; the data-collecting work should be entrusted to national groups which are proficient in "waste water" and standardised at the Euro-Mediterranean scale.

- **BETTER PLANNING:** Implementing a circular and sustainable approach, in order to offer a treated waste water that is adapted to its future use, while integrating in the REUSE project the whole recycling chain, from the discharge of waste water to its reuse. Favouring local distribution channels to enhance local activities. Resorting to a water-energy-agriculture nexus approach to make the most of all potential solutions.

- **BETTER INTEGRATING:** Using the REUSE approach can reinforce the bond between a city and its territory. Developing sanitation and the REUSE in peri-urban and rural spaces, often lagging behind in relation to urban centres, via a decentralised approach and nature-based solutions. Involving local communities (especially local authorities), from the beginning, into the governance of projects.

- **BETTER SUPERVISING:** Adopting a more flexible, pragmatic and ambitious approach of the REUSE in national strategies, especially by making the development of decentralised projects easier. Creating an inter-regional normative framework on waste water and treatment sub-products.

- **BETTER FINANCING:** Developing ways to finance projects, especially by resorting to the private sector (PPPs). Amortizing the investment and recovering the costs, and developing projects' sustainability through an innovative approach in terms of pricing and on-site value creation.

- **BETTER INFORMING:** Integrating the civil society by developing awareness tools, in order to inform populations on the necessity to control water consumption. Facilitating cooperation between political, economic and academic spheres. Taking into account the cultural or religious obstacles, if they are a source of concern regarding the REUSE, in order to find solutions.

- **BETTER COOPERATING:** Developing South-North, North-South and South-South cooperation initiatives on the REUSE, possibly via the creation of an inter-regional governance framework, capable to launch call for innovative projects. Encouraging experience- and technology-sharing to boost the capacities of the region's countries.

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WEBSITES AND DOCUMENTS AVAILABLE ON-LINE:

- Summaries of the Working Groups organised by IPEMED and its partners:
www.ipemed.coop
- World Bank data:
https://donnees.banquemondiale.org/indicateur/SH.STA.BASS.ZS
- European Environment Agency data:
https://www.eea.europa.eu/data-andmaps/indicators/urban-waste-water-treatment/urban-waste-water-treatment-assessment-4
- FAO - AQUASTAT data:
www.fao.org/NR/WATER/AQUASTAT/main/indexfra.stm
- NGO Grid-Arendal website:
www.grida.no/resources/5908

MEMBERS OF THE WORK GROUP

The work group includes the participants to the various workshops on the REUSE that were co-organised by IPEMED and its partners:

- **Regional workshop to launch the preparatory Mediterranean process to the 8th World Water Forum**, Monaco, 11 July 2017
- **Pollutec Maroc Show**, workshop "Waste water: an untapped resource for agriculture", Casablanca, 24 October 2017
- **3rd Mediterranean Water Forum**, Session #4 - Urban topic: the REUSE and its impacts on cities and territories, Cairo, 23 January 2018

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