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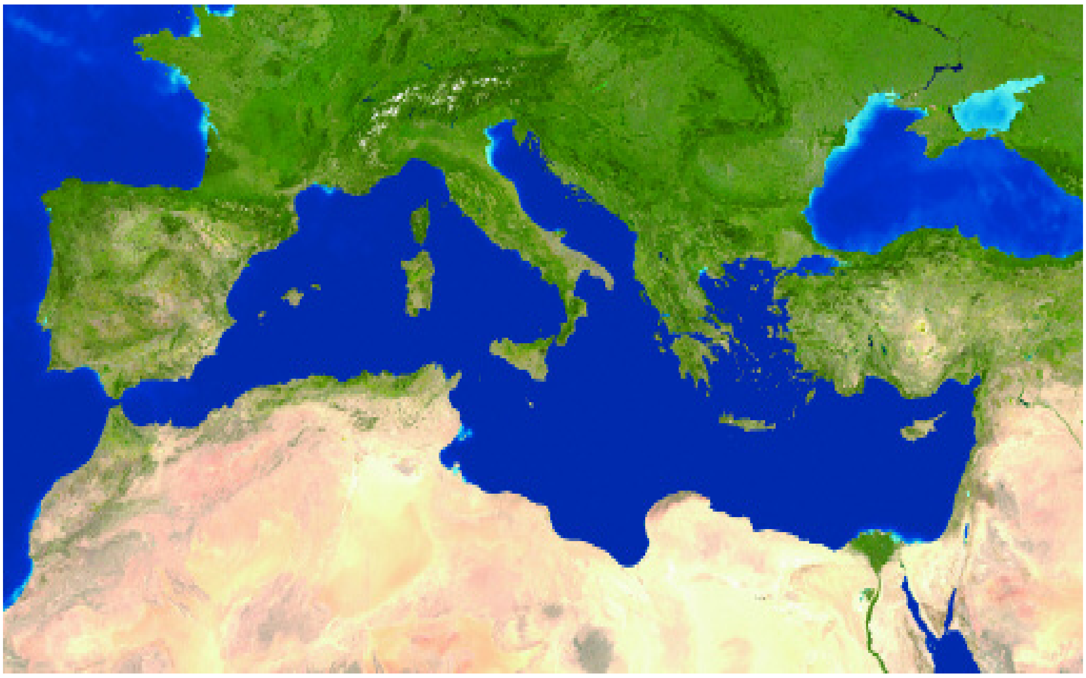

Mediterranean Wastewater Reuse Report

Produced by the

MEDITERRANEAN WASTEWATER REUSE WORKING GROUP (MED WWR WG)

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http://www.emwis.net/topics

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1 PREFACE

In their previous works, the MED-EUWI Working Group on Water Scarcity and Droughts identified treated wastewater reuse as a way of addressing long term imbalances between demand and water supply, whereas the MED-EUWI Working Group on Groundwater recognised the importance of its potential impact on the quality of groundwater.

The Working Groups also acknowledged that, at the European level, there were no formal definitions or guidelines addressing the issue of treated wastewater reuse. Final recommendations from the working groups highlighted the need for further investigations on the topic of demand management, treated wastewater reuse and for coordination and information exchange between the EU Member States, partner countries covered by the MED-EUWI, the European Commission, and other interest groups. In light of the above, it was proposed to set up a MED-EUWI Working Group for wastewater reuse under the second phase of the MED-EUWI Joint Process.

This report represents the major output of the MED-EUWI Wastewater Reuse Working Group (WWR-WG). The report presents a way forward by seeking to identify the main objectives of a treated wastewater reuse policy and the existing barriers and constraints which will have to be overcome if wastewater reuse strategies are meant to gather more momentum and be adopted on a larger and more effective scale than at present. It is the first step for collecting information on the current status of wastewater reuse in the European Union (EU) and the Mediterranean in order to obtain an overview of the issues at stake.

In line with its mandate, the WWR-WG has endeavoured to build on and recognise all available information in an effort to compile a reference dossier, without duplicating knowledge which is already in circulation. The work of the group is not meant to *reinvent the wheel*[1] but rather to complement and support current know-how by addressing wastewater reuse in the context of the socio-economic and environmental benefits.

Previous works showed that there exists a disparity of reuse practices from north to south, across the Mediterranean, both in EU and non-EU countries. New initiatives should therefore drive towards making reuse processes more amenable, robust and safe, by setting basic qualitative standards and other subsidiary ones that take into account regional specificities, intended applications and government planning of integrated water supply and management (IWRM).

Even though our river basins depend on treated wastewater mixed with surface water drainage to maintain water resources for safe abstraction, it appears that in several countries, the reuse of treated wastewater is still shrouded in a mist of apprehensions, possibly as a result of misconceptions, lack of knowledge and wrong stakeholder and public perception. Policies are unclear, when present, and institutional capabilities to manage wastewater reuse are often lacking.

[1] Based on several projects such as the research project AQUAREC http://www.aquarec.org/ or the MEDA Water projects such as EMWater (www.emwater.org)

The widespread practice of reuse of untreated wastewater for agricultural production with public health risks in many Mediterranean countries is a very important subject to be regulated to guarantee the safe use of treated wastewater and safe food production.

Regulatory and institutional aspects, planning, financing, implementation and operation of wastewater reuse projects are amongst the most important themes to be considered for further development, if reuse of treated wastewater is intended to be a meaningful and an acceptable alternative to the community, both in terms of sustainability and affordability.

Within the EU, at least two major environmental directives, directly or indirectly, raise the issue of wastewater reuse insofar as these directives lead towards two primary objectives:

a The Urban Wastewater Treatment Directive (91/271/EEC) requires that *"treated wastewater shall be reused whenever appropriate"* under the requirement of "minimising the adverse effect on the environment" in the light of the objective of first article of the same directive which is clearly defined as the protection of *the environment from the adverse effects of wastewater discharges.*

b On the other hand the Water Framework Directive (WFD) (2000/60/EC) refers, under Annex VI (v) to *"emission controls"* and under Annex VI(x) to *"efficiency and reuse measures, inter alia, promotion of water efficient technologies in industry and water saving techniques for irrigation",* as two, non-exclusive list, supplementary measures. Again these measures have to be perceived in the light of the achievement of the environmental objectives laid down in Article 4, namely that of achieving good environmental status of water bodies.

Hence wastewater reuse needs to be perceived as a measure towards three fundamental objectives within a perspective of integrated water resources management:

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

In addition to these objectives, the public health perspective should be considered. The most common quality standards which are followed are those by World Health Organisation (WHO) the US-EPA standards, and a few others being applied in some countries. The issue that needs to be examined carefully is whether these standards suffice in addressing safety requirements for wastewater reuse in the Mediterranean and EU, taking also into account the recent reviews conducted by WHO. Quality assurance is vital to consumer acceptance. If found lacking, then further development is required to increase the level of safety - an issue which the WG examined and recommended additional work in this respect.

There is also the question whether the governing standards in some countries and within the countries are useful or constrain reuse applications unnecessarily. This is where the input of national expertise contributed to the work of the group by providing detailed information of the situation "on the ground", and compiled in the report of the WWR-WG.

Some overarching priorities were listed *a priori* for consideration in a policy formulation exercise:

- Regulatory roles of institutions, to establish a basic system of good governance and compliance with environmental and health-related legislation. Linkage with related policies; land-use, Common Agricultural Policy (CAP), urban-planning.
- Social impacts of wastewater reuse development in relation to specific sectors; agriculture and industry.
- Cost-benefit and cost-effectiveness (including economic impacts) of the reuse process; decentralised vs. centralised facilities, etc.
- Financing and cost recovery; putting in place economic and financial tools.
- Stakeholder involvement as key to acceptance of a reuse policy

It must be emphasised that these priorities are recognised across the Mediterranean for their regional significance, more so when considering the rising pressure on water resources as a result of climate change. Recommendations for potential policy formulation should therefore set strategic actions aiming towards the environmental, economic and social objectives, which, it must be emphasised, constitute also legally binding obligations for the Mediterranean EU countries.

Policy considerations are foremost. Goals have to be set and tailored for specific circumstances and situations taking into consideration the stakeholder response likely to be expected in practice. After all, the application of treated wastewater reuse will heavily depend on stakeholder acceptance and political commitment which, by and large, differs from country to country. It also involves institutional reform, and changing stakeholder behaviour by more public involvement and heightened awareness campaigning.

Within this framework, the working group has endeavoured to assess the current position on wastewater reuse in Europe and chart the way forward by setting the foundation for more specific, demand driven action "on the ground" to be taken at EU level.

2 KEY DEFINITIONS AND TERMINOLOGIES

This chapter outlines the definitions of commonly used key words. A comprehensive list is provided in **Annex 1**. The chapter also provides a brief understanding of the main categories of treated wastewater reuse applications.

2.1 KEY DEFINITIONS

There is no common agreement on the terminology for water reuse, including the concept of wastewater. This document refers to water reuse at large (as defined in WHO, EU IPPC BREF documents, AQUAREC, etc.) and includes examples of water recycling in the industrial sector.

This document is mainly focused on the reuse of wastewater which is treated after collection in urban areas. Therefore, the document will use the wording of the Urban Waste Water Treatment Directive which is: **"treated wastewater reuse"**.

Table 2.1 below gives the descriptions of seven key terms related to wastewater reuse.

Table 2.1 Key terms

Term	Definition
Wastewater	Liquid waste discharged from homes, commercial premises and similar sources
Treated wastewater reuse	Beneficial reuse of appropriately treated wastewater
Restricted irrigation	The used of treated wastewater to grow crops that are not eaten raw by humans
Unrestricted irrigation	The use of treated wastewater to grow crops that are normally eaten raw
Urban landscape irrigation	The irrigation of parks, road margins sports facilities etc
Environmental enhancement	The restoration or creation of wetlands, water parks etc that enhance the local environment
Aquifer recharge	Controlled replenishment of groundwater naturally by precipitation or runoff or artificially by spreading or injection

2.2 DEFINITIONS OF TREATED WASTEWATER REUSE APPLICATIONS

Treated wastewater is normally disposed of in natural water bodies; then it can be withdrawn for reuse at some point that is spatially or temporally separated from the treated wastewater discharge point. In these cases the treated wastewater is diluted, transformed, or both by the receiving water before use. This can be considered as indirect reuse. In the case the treated wastewater is transported without dilution directly to its application we speak of direct reuse.

2.2.1 *Direct treated wastewater reuse (without storage in surface or groundwater body)*

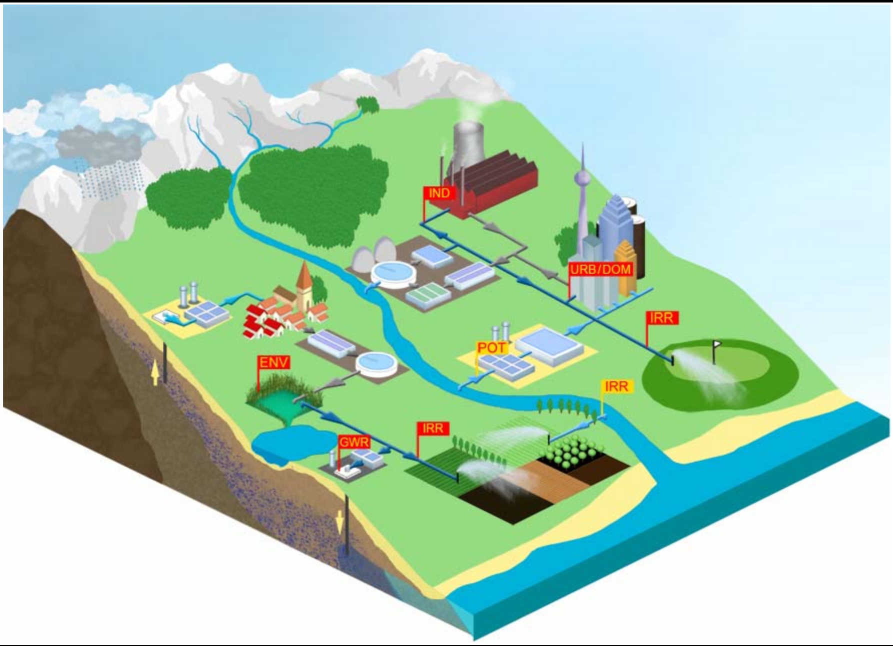
The applications of direct treated wastewater reuse include:

- Irrigation water (agriculture, landscape, sport and recreation).

- Water for manufacturing and construction industry (cooling and process water).
- Dual water supply systems for urban non-potable use (toilet flushing and garden use).
- Fire fighting, street washing, dust suppression and snowmaking.
- Water for restoration and recreation of existing or creating new aquatic ecosystems.
- Recreational water bodies (including land redevelopment[1]).
- Aquifer recharge through injection wells for saline intrusion control.
- Fish ponds.

Figure 2.1 gives a schematic of a direct treated wastewater reuse for irrigation and industry.

Figure 2.1 Direct treated wastewater reuse to reduce demand on potable water and high quality water sources more suitable for potable production (potable substitution)[2]



Source: Veolia, 2006; ENV (Environment), IRR (Irrigation), URB/DOM (Urban/ Domestic), POT (Potable), IND (Industry) and GWR (Groundwater recharge).

2.2.2 *Indirect treated wastewater reuse (with storage in a surface or groundwater body before use)*

The reuse after incorporation of treated wastewater into a raw water supply can be described as indirect reuse. Planned indirect potable reuse is the deliberate incorporation of treated wastewater into a raw water supply such as a river, catchment reservoir or aquifer resulting in mixing and assimilation thus providing an environmental buffer (before potable treatment).

The applications include:
- Increasing water availability for potable water production.
- Increasing storage and water availability for industry.
- Aquifer recharge for saline intrusion control and delayed abstraction to increase water resources in quantity and quality.

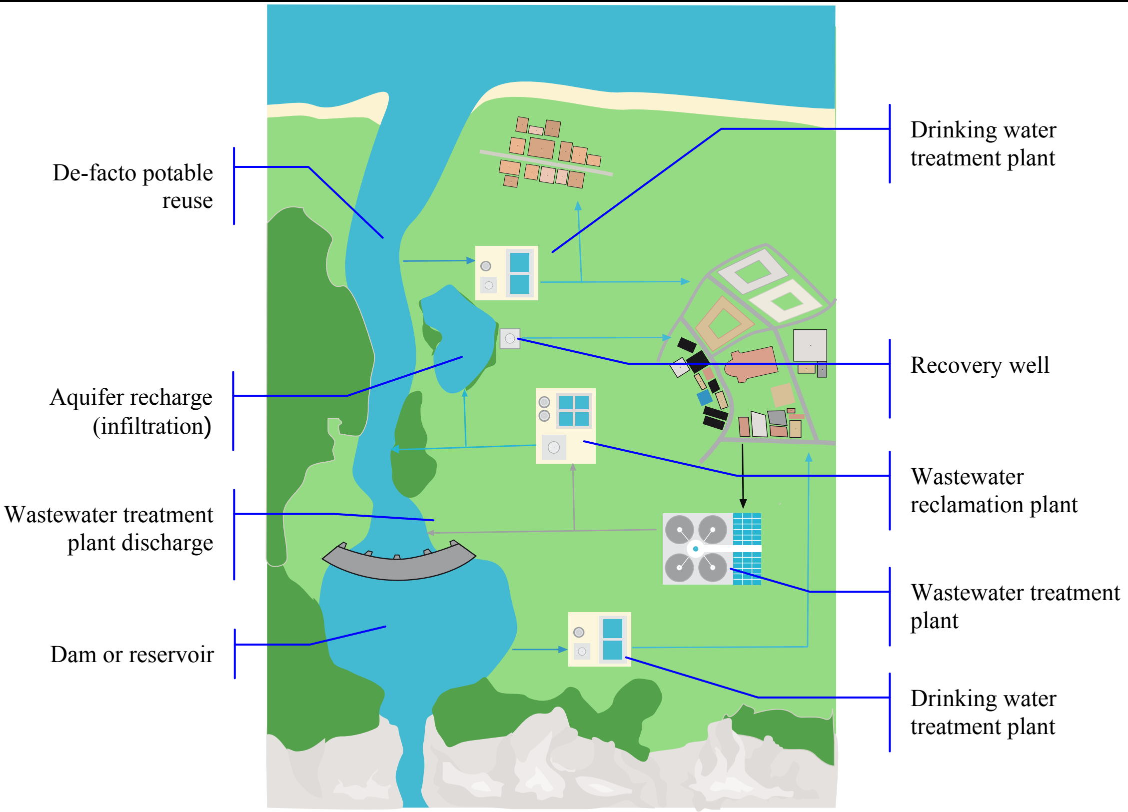
[1] Using treated wastewater to enhance the redevelopment of old industrial sites into attractive water parks for the community to increase quality of life and land value. (Sydney Olympic Park and Seoul Korea)
[2] Adopted from Veolia Environment (2006)

Unplanned or "**de facto**" indirect reuse can be described as the discharge of treated wastewater into the river which is then diluted with surface run off before being abstracted for potable treatment downstream. In EU countries, as in most of the highly populated countries, indirect potable reuse through groundwater recharge and surface water augmentation, along with new infrastructure approaches, is a common situation. It is inevitable in urban areas and will represent an essential element of sustainable water resources management in the future.

Indirect potable reuse is common in cities such as London, Berlin, and Barcelona.

Figure 2.2 illustrates the concepts of de-facto and planned.

Figure 2.2 De-facto, indirect potable reuse is a well established practice



Source: AQUAREC

3 BENEFITS AND RISKS SUMMARY (ECONOMIC, SOCIAL, HEALTH AND ENVIRONMENTAL)

This chapter summarises the key economic, environmental, social, and health benefits and risks. Benefits and risks depend on the type of treated wastewater reuse application, appropriate treated wastewater quality, health risk and level of exposure, geography, local economics, subsidies and grants and on many other issues.

3.1 ECONOMIC BENEFITS AND RISKS

Economic Benefits

Treated wastewater can:

- Serve as a more dependable water source. The quantity and quality of available water may be more consistent compared to surface water, as municipal treated wastewater volumes are less affected by droughts than surface and groundwater bodies. This can lead to reduced production costs, sustained agricultural and industrial production and associated employment (e.g. Costa Brava, Gerringong and Kwinana).
- Enhance urban, rural and coastal landscapes, thereby increasing employment and local economy through tourism (e.g. Barcelona, Costa Brava, Sainte Maxime, Sperone, Honouliuli, and Gerringong).
- Be substituted for freshwater or potable water to meet specific needs and purposes (such as irrigation, toilet flushing, cooling and process water etc.), thereby contributing to more sustainable resource utilisation and sound demand management.
- Contain useful materials, such as organic carbon and nutrients like nitrogen and phosphorous. The use of nutrient-rich treated wastewater for agriculture and landscaping may lead to a reduction or elimination of fertilizer application or increased productivity (e.g. Costa Brava, Gerringong and Berlin).
- Reduce overall water consumption and treatment needs, with associated cost savings. In many applications, treated wastewater reuse is less costly than using freshwater, pumping deep groundwater, importing water, building dams or seawater desalination. (e.g. IWVA Toreelle and Orange County).
- Reduce the investment in new water headworks for water abstraction and treatment, distribution networks and new sewerage investment by substituting treated wastewater for non potable applications and thereby increasing the availability of potable water (e.g. Eraring, Durban & Honouliuli). Meeting a growing demand for water resources (especially in urban areas) may require the development of additional large-scale water resources and associated infrastructure. By meeting some of this demand through treated wastewater reuse and efficiency improvement, additional infrastructure requirements and the resulting financial and environmental impacts can be reduced or, in some cases, eliminated altogether.

Economic risk

The main economic risks are:

- The economic impact of public health epidemics or environmental pollution resulting from unsafe treated wastewater reuse practice due to lack of guidelines and guideline application, or access to good practice know how.
- Weak economic justification when water prices do not cover the true cost.
- The local market demand for treated wastewater is not clearly defined and agreed
- Good opportunities are lost through simplistic economic analysis that does not consider whole life cost or economic externalities.
- High distribution and storage costs due to the distance between supply and demand locations.
- Negative branding of treated wastewater reuse by the general public.

3.2 SOCIAL AND HEALTH BENEFITS AND RISKS

Social and Health benefits

The social benefits of treated wastewater reuse include the following:

- The use of common treated wastewater reuse guidelines that include an appropriate risk management approach and good practice know how helps to <u>protect public health</u> for all applications and especially for fruit and vegetable production to ensure food safety in the local, EU, Mediterranean and export markets.
- Helping to achieve Millennium Development Goals (MDG) through increased water availability and <u>poverty reduction</u> (e.g. Durban) through the use of appropriate technology solutions.
- Contributes to <u>food security, better nutrition</u> and <u>sustains agricultural employment</u> for many households.
- Be a cohesion tool that encourages the drinking water, wastewater and environment agencies and other stakeholders to work closely together using an integrated approach, thereby helping all to recognise the benefits and risks of treated wastewater reuse and encourage good practice that benefit the community (e.g. Costa Brava).
- <u>Increased quality of life</u>, well being and health through attractive irrigated landscapes in parks and sports facilities in rich and poor communities (e.g. Empuriabrava and Costa Brava) and improvement of urban environment (e.g. urban parks and fountains).

Social and health risks

These include:

- Threat to public health, especially if illegal and unhealthy wastewater reuse practice expands rapidly due to water scarcity, over stringent regulation or the lack of appropriate treated wastewater reuse guidelines and good practice know-how.
- Social tensions in case of non-acceptance: a common perception is that wastewater treatment is needed to dispose of waste rather than a community's responsibility to protect public health, the environment and increase water availability needed for economic growth.

3.3 ENVIRONMENTAL BENEFITS AND RISKS

Environmental benefits

- Treated wastewater reuse allows for the conservation and rational allocation of freshwater resources, particularly in areas under water stress.
- Reuse increases the total available water supply and reduces the need to develop new water resources and therefore provides an adaptation solution to climate change or population density induced water scarcity by increasing water availability (e.g. Osaka, Durban).
- The use of treated wastewater reduces the amount of discharges and therefore the level of nutrients or other pollutants entering waterways and sensitive marine environments (e.g. Pornic, Gerringong).
- Provides a mitigation solution to climate change through the reduction in green house gas by using less energy for wastewater management rather than importing water, pumping deep groundwater, seawater desalination or exporting wastewater (e.g. Toreele, Orange County).
- The use of treated wastewater in the manufacturing industry reduces fresh water demand, recovers heat and reduces industrial wastewater production with a drought proof water source compared with surface water or groundwater (e.g. West Basin, Kwinana).
- The beneficial reuse of water of an agreed quality forces the wastewater treatment to be operated efficiently in order to satisfy the consumer. A decline in treated water quality from the wastewater treatment plant will often stop the reuse application from operating, whereas a poor quality discharge to surface water will probably not be noticed. This will ultimately lead to additional environmental benefit by way of more stringent compliance to Art 4 of the UWWTD 91/271/EEC.
- Reduces the need for chemical fertilizers.
- Reuse increases the quantity of solid waste from treatment plants, which with efficient quality control, can be valuable products such as soil conditioners, biofuel or nutrients for biogas heat and energy production. These can improve soil condition and agricultural productivity; reduce green house gas production and energy demand.
- Treated wastewater reuse can be used to enhance the environment through the augmentation of natural/artificial streams, fountains, and ponds. The restoration of streams, wetland, and ponds with treated wastewater has contributed to the revival of aquatic life, and created urban spaces and scenery (e.g. Costa Brava, Empuriabrava and Meguro River). The recovery of water channels has great significance for creating 'ecological corridors' in urban areas and green belts to control soil erosion by wind in arid regions.
- Treated wastewater can be used to recharge aquifers. Compared to conventional surface water storage, aquifer recharge has many advantages, such as negligible evaporation, little secondary contamination by animals, and no algal blooming. It is also less costly because pipeline construction is not required and is a fraction of the cost of surface storage. Furthermore, it can protect groundwater from saltwater intrusion by barrier formation in coastal regions, and controls or prevents land subsidence.

Environmental risks

- Hazardous or toxic waste and salts from industry and salt leaching processes in agriculture can reduce the quality of the wastewater and risk public health and creates negative effects on the environment. They need to be prevented by wastewater source protection and efficient regulation.

- Treated wastewater is also essential to maintain the surface water potential and indirectly, through percolation from surface water bodies, the capacity of groundwater bodies. Recharge may well be a higher priority and therefore restrict the treated wastewater available for irrigation or other applications.
- The impact and risk of concentrated wastes produced by wastewater treatment, such as brackish reverse osmosis concentrate and sludges, need to carefully managed.
- Reused treated wastewater may constitute an additional pressure onto the aquatic environment. Emerging pollutants such as pharmaceuticals and endocrine disruptors may affect the ecological or human health (which needs to be considered in the assessments foreseen by Water Framework Directive).

4 IMPORTANCE OF TREATED WASTEWATER REUSE IN THE EU-MEDITERRANEAN REGION

4.1 INTRODUCTION

The increasing demand for water, combined with frequent drought periods, even in areas traditionally rich in water resources, puts at risk the sustainability of current living standards. Global trends such as urbanisation and migration have increased the demand for water, food and energy. The forecasts for water availability are quite dire. This emphasises the need for water scarcity solutions and water quality protection from pollution.

In Europe and the Mediterranean there is an urgent need to improve the efficiency of water use, to implement water demand management practices, and to augment the existing sources of water with more sustainable alternatives. Numerous solutions, modern and traditional, exist throughout the world for efficiency improvements and augmentation. Treated wastewater reuse has become increasingly important in water resource management for environmental, economic and social reasons. When appropriately applied, reuse is considered as an example of environmentally sustainable technology (EST)[1]. ESTs play a key role in facilitating freshwater protection and integrated water resource development and management, as recognized in Chapter 18 of Agenda 21. Treated wastewater reuse more appropriately matches water use application with water resource quality, resulting in more effective and efficient use of water and the goal of water resource sustainability is more attainable when viable treated wastewater reuse options are implemented. However, treated wastewater reuse is one of range of alternatives to increase water availability and management; others include water efficiency, demand management, developing new freshwater resources, maximising rainwater catchment, increasing storage and seawater desalination.

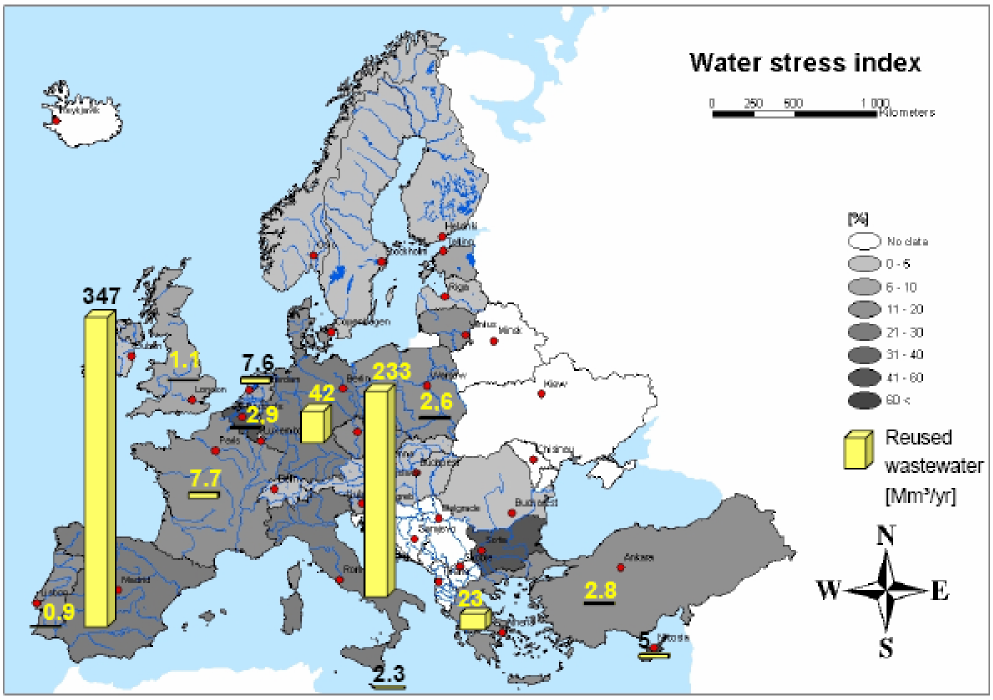
4.2 PRESENT STATUS OF TREATED WASTEWATER REUSE PRACTICE IN EU AND THE MEDITERRANEAN

The status of treated wastewater reuse practice is evolving continuously. Quantitative information on wastewater treatment and reuse is difficult to obtain. The data presented here on European countries are from a survey conducted within the AQUAREC project and represent the activities identified up to the year 2004. Where volumetric information was not available, used amounts were estimated according to irrigated area. Data on the Mediterranean countries can be found e.g. in publications by the World Bank and WHO-CEHA (World Bank 2007, WHO-CEHA 2005).

Figure 4.1 illustrates the reused volumes per country.

[1] UNEP 2006. Water and Wastewater Reuse: *An Environmentally Sound Approach for Sustainable Urban Water Management (* www.unep.or.jp)

Figure 4.1 Water stress and treated wastewater reuse in Europe



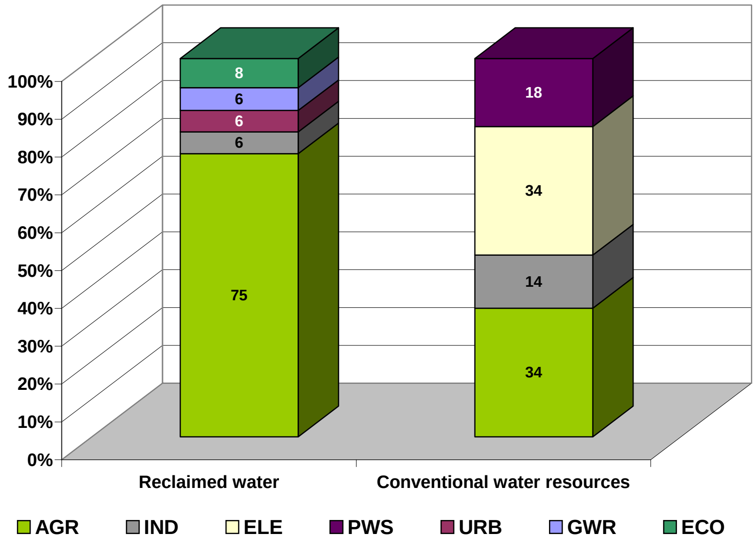
Source: AQUAREC, 2006 / Wintgens et al, 2005 (updated)

The total volume of reused treated wastewater in Europe is 964 Mm³/a, which accounts for 2.4% of the treated effluent. Spain accounts for largest proportion of this (347 Mm³ /yr); Italy uses another 233 Mm³/yr. In both countries, agriculture absorbs most of the treated wastewater. Israel is another large user of treated wastewater, (280 Mm³ per year, around 83% of the total treated wastewater). The treated wastewater reuse rate is high in Cyprus (100%) and Malta (just under 60%), whereas in Greece, Italy and Spain treated wastewater reuse is only between 5 % and 12 % of their effluents. The amount of treated wastewater reused is mostly very small (less than 1%) when compared with a country's total water abstraction. Only Malta and Israel augment their water supply by 10 % and 18 % respectively, using treated wastewater as an alternative source.

According to World Bank 2007, on average, across the region of the Middle East and North Africa (MENA), 2 % of water use comes from treated wastewater. Jordan is reusing up to 85 % of treated wastewater and Tunisia 20-30%. Egypt and Syria reuse treated domestic wastewater to some extent. Moreover, the Gulf countries use about 40 % of the wastewater that is treated to irrigate non-edible crops, for fodder, and for landscaping.

As depicted in **Figure 4.2** three quarters of the treated wastewater is applied in agriculture for irrigation. The remaining quarter is almost equally shared between industrial applications, urban uses, groundwater recharge and ecological enhancement. It becomes evident that compared to the use of freshwater resources reclaimed irrigation applications are "over-represented" whereas the industrial and cooling water sector is hardly making use of wastewater recycling.

Figure 4.2 Water use and reuse of European countries by application

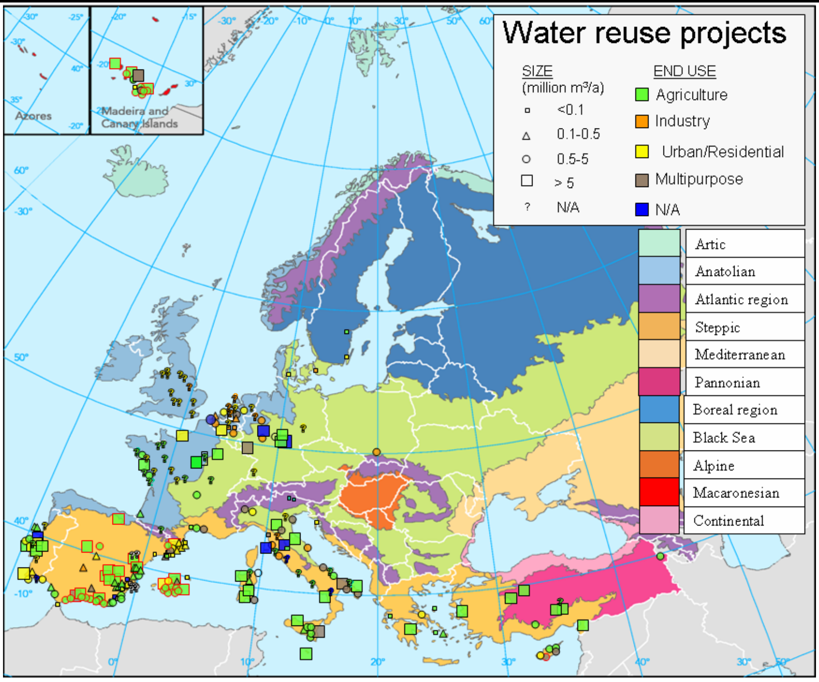


Source: AQUAREC, 2006; Legend*:* AGR: agricultural irrigation, GWR: groundwater recharge, IND: industrial use, ELE: electricity generation, PWS: public water supply, ECO: ecological/environmental enhancement, URB: urban and domestic uses

In Europe most reuse schemes are located along the coastlines and islands of the semi-arid Southern regions, and in the highly urbanised areas of Northern and Central Europe. **Figure 4.3** shows the geographic distribution of treated wastewater reuse projects identified and collated by the AQUAREC project in 2004. The scale of the projects is broken down into four classes: very small (<0.1 Mm^3/a), small (0.1-0.5 Mm^3/a), medium (0.5-5 Mm^3/a) and large (>5 Mm^3/a). **Figure 4.3** also shows that the use of treated wastewater is quite different in those two regions: in the EU Mediterranean countries, treated wastewater is reused predominantly for agricultural irrigation (44% of the projects) and for urban or environmental applications (37% of the projects), whereas in Atlantic and continental Europe, reuse occurs mainly in urban and environmental (51% of the projects) or industrial applications (33% of the projects).

In the MEDA countries, reuse of treated wastewater is predominantly for agriculture. Irrigation for landscaping and golf courses is also increasing. A selection of reuse projects in the MEDA region can be found in the EMWater Guide, prepared within the EU funded MEDA Water programme (Kramer et al. 2007).

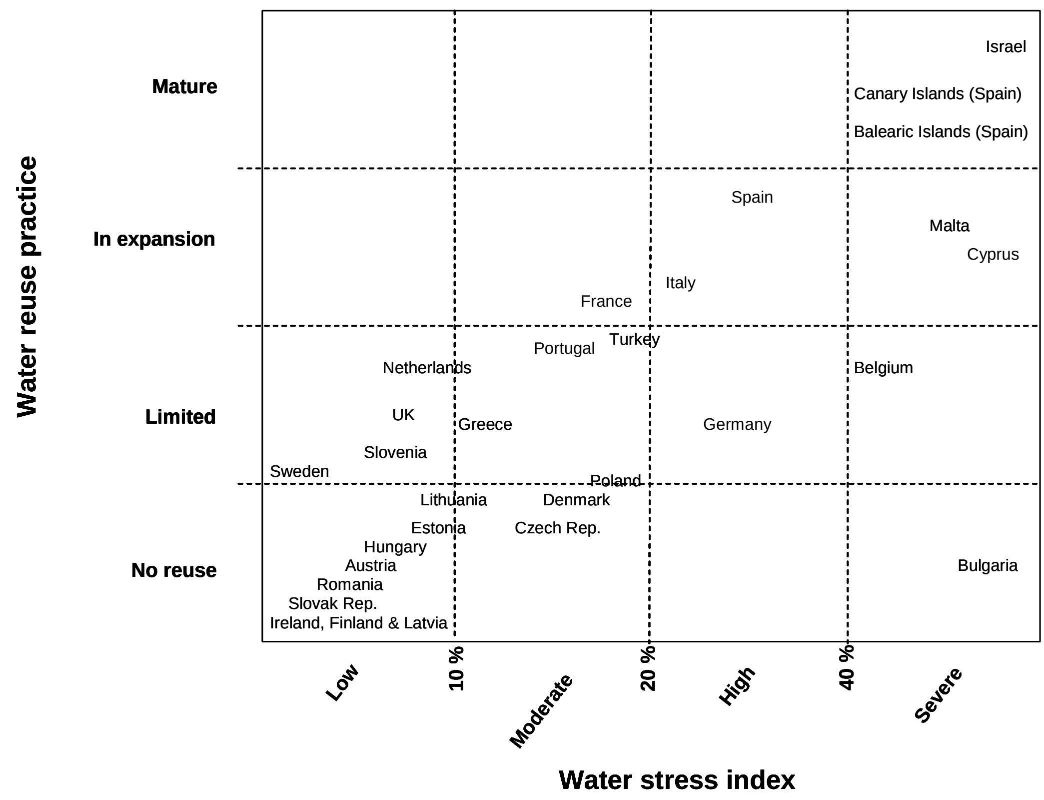
Figure 4.3 Selected treated wastewater reuse projects in Europe



Source: AQUAREC, 2006

The current status of treated wastewater reuse and water stress in Europe is summarised in **Figure 4.4.** The figure compares the extent of treated wastewater reuse practice with the severity of water stress, for a number of countries. It is obvious that some water stressed regions have already achieved a rather mature treated wastewater reuse practice (e.g. Israel and the Canary and Balearic Islands in Spain), whereas others are still in the phase of expanding their activities (e.g. mainland Spain and Italy). This represents a semi-quantitative assessment and partly reflects the (demand driven) improvement of the framework conditions, such as regulation, and the degree of institutional organisation relevant for the establishment of reuse (guidelines, financial support etc.).

Figure 4.4 Extent of treated wastewater reuse practices in European countries versus their water stress index



Source: Bixio et al., 2006

4.3 *DRIVERS FOR TREATED WASTEWATER REUSE*

4.3.1 *The increasing demand for water*

The demand for water increases with population and economic growth. This affects all water use sectors: public water supply, agriculture, industry, and power generation. Generally, most countries in Europe (with the exception of a few countries such as Ireland, the UK, France and the Netherlands) will not experience significant population growth. In a few European countries (e.g. the Baltic States, Bulgaria and Hungary), the population is even expected to decline. However, the countries of the Eastern and Southern Mediterranean are expected to have the most significant population growth (up to 25 % by 2025, Plan Bleu, 2005). Many of the countries in this region have varying degrees of water scarcity. The population growth will increase water demand and further exacerbate this scarcity. Furthermore, increased urbanisation and migration will lead to further increases in water demand especially in towns and cities.

Tourism is also responsible for seasonal peak demands and poses a particular challenge for the water supply in Mediterranean (mainly coastal regions) during the summer months. Water demand related to tourism includes potable water for domestic and leisure uses (swimming pools) and irrigation water for recreational parks and golf courses.

Agriculture is the dominant water use in Southern European countries. As irrigated agriculture is more productive and profitable, the use of irrigation has grown significantly over the past two decades, with France, Greece, Portugal and Spain accounting for most of this growth. This trend has partly been fostered by government subsidies and the Common Agricultural Policy (CAP). In addition EU directives promoted the right balance between competitive agricultural production and the respect of nature and environment. Control of fertiliser application and pollution by pesticides and conservation of the soil fertility are also taken into account for reuse projects too (CAP-regulation, the common agricultural policy).

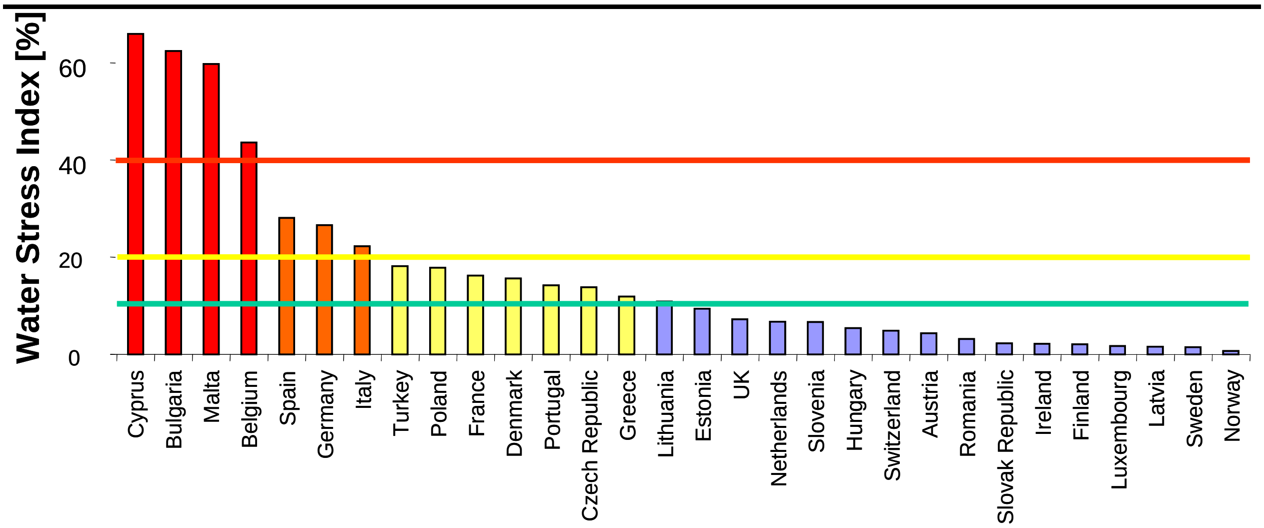
4.3.2 Water stress and adaptation to water scarcity and climate change

Water stress

Water stress is the over proportionate abstraction of water in relation to the resources available in a particular area. The water stress index is the ratio between total freshwater abstraction and total annual renewable resources and indicates the pressure on water resources. The water stress index is a rough indicator for the urgency of water management in order to maintain supply and avoid conflicts amongst competing uses/users. The OECD (2003) defines water use intensity of more than 40% as high water stress, 20% to 40% classifies as medium-high, whilst more than 10% is defined as moderate water stress.

As depicted in **Figure 4.5** water stress is high in countries like Cyprus, Malta, Belgium and medium high in Spain, Germany and Italy. Turkey, France, Poland, and Greece are classified as moderately water stressed. A recent survey on the issue of water scarcity on a regional level came to the result that in 12 EU member states 26 river basins are affected by water scarcity representing 10% of the EU territory and 14% of the population (EC, 2006).

Figure 4.5 Water stress index for European countries



Source: AQUAREC, 2006 / Hochstrat et al, 2006,(based on data of EEA and national state of the environment reports)

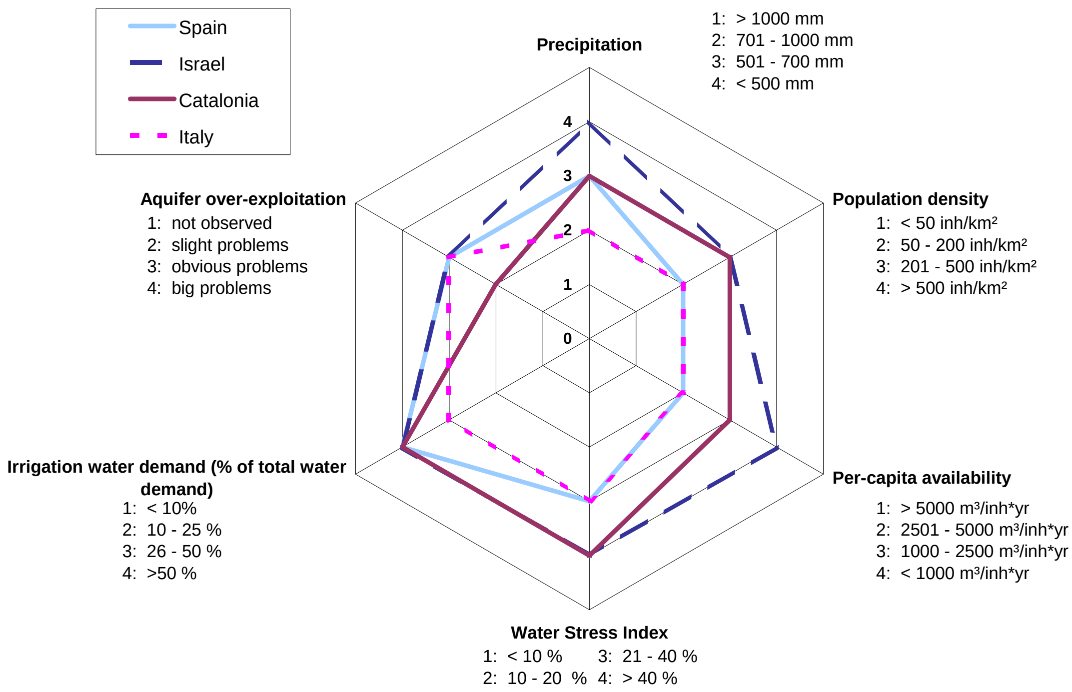
Information on water scarcity and drought in the EU is available in the in-depth assessment carried out by the European Commission[1] and in the Communication on water scarcity and drought adopted in July 2007[2].

Declining water availability calls for more integrated approaches to balance supply and demand in future. **Figure 4.6** illustrates the situation for some Mediterranean countries

[1] http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/scarcity_droughts/technical_report_2006&vm=detailed&sb=Titl e
[2] http://ec.europa.eu/environment/water/quantity/scarcity_en.htm

(Spain, Italy and Israel) and regions with regard to water management relevant parameters such as precipitation, population density, water use and alike. These regions score high for most categories, indicating a multi-factor water stress.

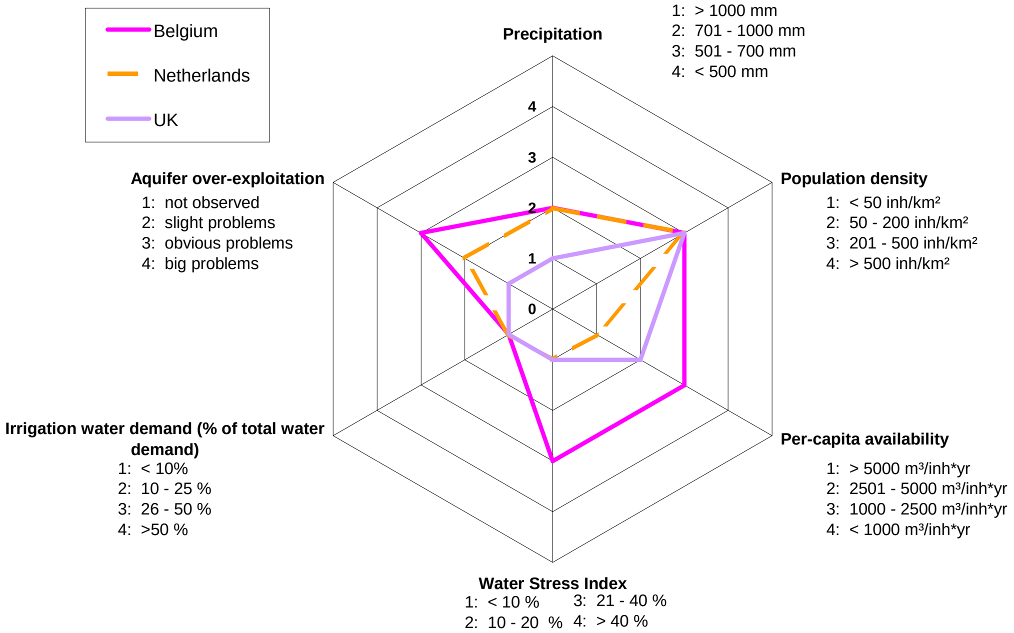
Figure 4.6 Spider chart comparing some major water management characteristics of Mediterranean countries and regions



Source: AQUAREC, 2006

The shape of the spider diagrams (**Figure 4.7**) for some Western European countries (Belgium, Netherlands and the UK) show some striking differences, expressed in a higher precipitation and an almost negligible irrigation water demand. Although considered "water-rich" the per capita water availability is approximately in the same range as for dryer regions. High population densities in turn often exert pressure on water quality.

Figure 4.7 Spider chart comparing some major water management characteristics of western European countries and regions.



Source: AQUAREC, 2006

Adaptation in the face of water scarcity and climate change

Climate change and water scarcity are some of the main drivers for developing new resources through treated wastewater reuse. These changes will most likely result in a twofold mitigation and adaptation approach. The recent report of the European Environment Agency on “Climate Change and Adaptation issues” summarises a survey among European countries and their approaches to cope with climate change impacts. Among the measures considered or already taking place to face drought issues are: use restrictions and treated wastewater reuse development (EEA, 2007). The pressing global need to shift from a reactive crisis management approach to a proactive risk management approach has already been recognised in the Report on Climate Change and the European Water Dimension (EC-JRC 2005).

Recently a series of countries have enacted drought decrees or drought plans that to a certain degree foresee use restrictions and allocation of scarce water resource to the most prioritised use, which is drinking water supply. Curtailments of other users will have negative economic implications for the industrial and agricultural sector. In this context treated wastewater can offer an alternative resource for uses not requiring the stringent standards of drinking water quality.

Another impact of climate change and the resulting temporary water shortage is reduced river run-offs causing higher concentration of pollutants. These pollutants have either been discharged from point sources or entered from diffuse sources. Drinking water production can be particularly negatively impacted by this fact. During the drought in summer 2003, in the Netherlands, the low flow in main raw water resource led to intake restrictions of water suppliers due to low quality of water. Pumping stations (groundwater) were experiencing higher salinisation due to enforced seawater intrusion over estuaries during the low river flow periods of this summer.

When drinking water production cannot work at full capacity the demand for drinking water must be reduced. Demand management measures include promoting water saving devices and to replace part of the non potable drinking water demand by treated wastewater (potable substitution). Additionally, improvement of the water quality can be provided for by either treating municipal and industrial discharges with more advanced technologies or by simply avoiding effluent discharge through reclamation and reuse.

Box 4.1 provides a summary of scenarios of the availability of water in the future. Against this background, the use of treated wastewater can help to filling the gap between water demand and water production, after having managed the demand and reduce the economic disadvantages of water shortage or an unreliable irrigation water supply.

Box 4.1 Summary of the scenarios of the availability of water in the future

Climate change reports forecast considerably reduced availabilities for many South European river basins. The EuroWasser model (Lehner et al., 2001) has forecasted the impact of climate change on water availability in Europe according to two different Global Circulation Models for the time horizons 2020s and 2070s. According to their calculations, river basins will have heavily reduced water availability. Decreases of more than 10 % are projected for some continental countries (Poland, Hungary) and South Eastern countries (Bulgaria, Romania, parts of Turkey) whereas most South European countries will experience reductions of 25 % and more. A reduction of the mean annual flow in Portuguese river basins of 10 % to < 20 % was predicted as well by the First European Climate Assessment (EEA, 1996).

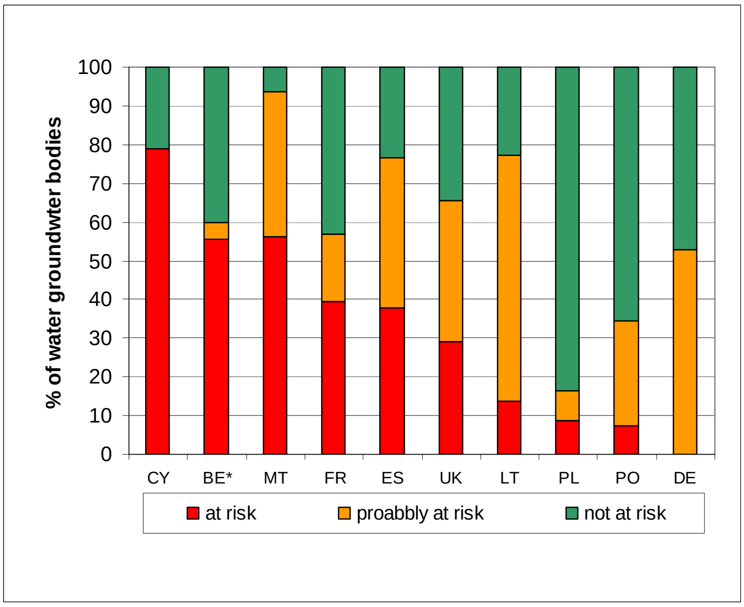
The latest Spanish report on the impact of climate change confirms this trend (MMA, 2006). The most prominent impacts of temperature increase due to climate change in Spain forecasts a diminished runoff and increased demand of irrigation systems. Even more important is the sensitivity of water resources towards temperature increase and reduced precipitation. For the semi-arid regions in Spain, a reduction of up to 50% of the actual available resources seems possible. For the horizon 2030, simulations show a temperature increase of 1ºC and reduced precipitation of 5% with an average decline in naturally available water resources between 5 and 14%. The situation for 2060 is even worse: with a temperature increase of 2.5 ºC, reduction in precipitation of 8% and an overall reduction of hydrological resources of 17%.

4.3.3 Groundwater

Groundwater resources are often exploited unsustainably, with abstractions exceeding the recharge rate. For some aquifers, the current rate of exploitation is close to or more than 100%) in various countries in the North Mediterranean basin (Spain, Italy, Greece, Malta, Cyprus) as well as in the South (Israel, Gaza, Libya, Tunisia). This means that there is over-exploitation of the water resource. The exploitation rate exceeds 50% in Turkey, Syria, Lebanon, the West Bank, Algeria and Morocco (MED EUWI, 2007). Excessive water abstraction can cause secondary effects in negatively affecting water quality. In addition groundwater resources are polluted by insufficiently treated municipal wastewater and uncontrolled industrial pollution and more and more aquifers are lost for direct drinking water supply due to diffused pollution.

Figure 4.8 illustrates the state of groundwater bodies as reported by the member states according to WFD, Article 5. The review of the national reports showed that in many countries a high share of groundwater bodies is at risk of not achieving a good status by 2015. Nitrate content, salinisation and pesticide pollutant range among the major reasons for missing this goal. Excessive withdrawal led also to a quantitative and qualitative deterioration of aquifers.

Figure 4.8 Status of groundwater in selected European countries



Source: AQUAREC, 2006

Numerous aquifers, particularly coastal ones in the Mediterranean region exhibit a high conductivity making them unsuitable for most water applications. An overview of the groundwater over-exploitation affected countries is given in **Figure 4.9**

Figure 4.9 Implications of aquifer overexploitation in European countries

	Groundwater over exploitation	**Groundwater over exploitation leading to**		**Nitrate pollution**
		Saltwater intrusion	endangered wetlands	
Country	X = yes	O = no		— = no data available
	bold print symbolises severe problems			
Austria	O	O	O	X
Belgium	X	X	—	**X**
Denmark	**X**	X	X	X
France	—	—	—	X
Germany	—	—	—	X
Greece	X	X	—	X
Italy	X	X	—	X
Netherlands	X	—	—	X
Portugal	X	X	O	X
Spain	X	X	X	**X**
UK	X	—	—	X
Israel	X	X	—	—
Cyprus	X	X	X	
Estonia	X	X	O	O
Hungary	X	O	X	X
Latvia	X	X	X	O
Lithuania	X	—	—	O
Malta	**X**	X	—	**X**
Poland	X	X	X	X
Slovenia	O	O	O	X
Romania	X	O	O	X
Turkey	X	X	X	

Source: AQUAREC, 2006

Due to the far reaching effects of the strategic groundwater management policies and approaches in the Mediterranean region should include controlling intensive exploitation of groundwater resources while among others increasing the utilization of additional and non-conventional water resources (MED-EUWI, 2007).

4.3.4 *Environmental protection and restoration*

Compliance of new and existing environmental regulations and more stringent pollution limit values also contribute towards the adoption of integrated approaches such as treated wastewater reuse. For example, the use of adequately treated wastewater for appropriate applications (e.g. for irrigation or industrial cooling/processes), instead of abstracting river water, can reduce or even cease the amount of wastewater discharged to water bodies, thereby leading to compliance with water quality legislation. The restoration and enhancement of natural habitats such as wetlands, their creation for environmental and recreational purposes can also be considered as emerging drivers for treated wastewater use.

4.4 *Conclusions and the Future of Treated Wastewater Reuse in the Urban Context*

The implementation of treated wastewater reuse is underdeveloped in the European as well as the southern and eastern Mediterranean context compared to other water stressed regions of the world such as California, Japan or Australia (Bixio and Wintgens, 2006). This is not only based on the total degree of water scarcity (which has forced the US and Australia to take a more comprehensive approach to water resources management), but also because urban treated wastewater reuse is not well understood compared with the high priority water management activities of potable water production to protect public health and wastewater treatment to protect the environment. Reuse can be more difficult to implement due to the large number of end users, the vicinity to the public, relatively high cost due to complex distribution and treatment systems as well as potential risks of accidental public exposure in the case of cross-connections in dual supply systems and irrigation of public spaces.

Factors such as the increased demand for water, coupled with increased water stress, water scarcity and the compliance measures towards environmental legislation, are likely to increase the drive towards the use of treated wastewater. The future of treated wastewater reuse can be viewed as a climate change adaptation solution as well. In some cases it can also be viewed as a climate change mitigation solution where water is reused locally with a lower energy cost than importing freshwater, exporting treated wastewater, reducing the investment in developing new water sources, sewerage and stormwater infrastructure. The benefits of treated wastewater reuse are very evident (see Chapter 3) even though some risks have to be taken into account. Treated wastewater reuse is vital in the widely promoted concept of "integrated urban water management".

Treated wastewater reuse alternatives should be included as part of the demand driven river basin management plans to maximise water management efficiency (see Gold Coast, Queensland Australia example in **Annex B**). In coastal regions the partial closure of the river basin water cycle is becoming common practice after the innovative solutions in Catalonia in Spain and France (See Costa Brava and Baix Llobregat project in Barcelona case studies in **Annex B**) where treated wastewater is used to recharge the river upstream of the City. Similar projects are being considered in the South East of England. This partial closure of the coastal water cycle follows the long term experience in cities such as Berlin (see case study **Annex B**).

5 *REFERENCE FRAMEWORK OF GUIDELINES FOR SAFE TREATED WASTEWATER REUSE*

5.1 *INTRODUCTION*

An increasing number of countries have produced legislative framework for the safe use of treated municipal wastewater. The legislative framework can be broken down into two types: regulations; and guidelines. Regulations are legally adopted, enforceable and mandatory, guidelines are advisory, voluntary and non-enforceable, but can be incorporated in treated wastewater reuse permits and in this way become enforceable requirements. Some international and national organisations prefer the use of guidelines to provide flexibility in regulatory requirements depending on site-specific and programme conditions which can result in differing requirements for similar uses. This is the case of international organizations, like WHO[1], and national organisations of federal governments, like US Environmental Protection Agency (EPA) and Australia, which can then be used as a resource by states that have limited, or no regulations or guidelines.

Generally, the guidelines are well structured so that they provide information on several aspects that are outlined in the following table:

Characteristics	WHO	US EPA	AUSTRALIAN
Treated wastewater Applications	(for Agriculture-Aquaculture)	●	●
Methods of Reuse	●	●	●
Treatment methods	●	●	●
Microbiological constituents	●	●	●
Chemical constituents	●	●	●
Physical Properties	●	●	●
Monitoring	●	●	●
Communication Strategies	●	●	●
Setback distances	●	●	●

The characteristics briefly described in the above table include:

1. Treated wastewater reuse applications: Agricultural irrigation, Landscape irrigation, Dual Distribution Systems and In-building Uses, Impoundments, Industrial uses, Aquifer recharge for non-potable purposes, Aquifer recharge for potable purposes, Aquaculture, Environmental enhancement and other non-potable uses;
2. Methods of Treated wastewater reuse: Agricultural irrigation, Surface irrigation, Sprinkler irrigation, Localized (drip) irrigation, Spray drift control (spray irrigation), Spray buffer zone (spray irrigation), subsurface irrigation;
3. Treatment: Secondary (activated sludge process, trickling filters, rotating biological contactors, stabilization ponds). Filtration (Passing treated wastewater through natural undisturbed soils, wetlands, sand, anthracite, filter cloth, or through microfilters or other membrane processes). Advanced wastewater treatment (chemical treatment, carbon adsorption, reverse osmosis and other membrane processes, air stripping, ultrafiltration, ion exchange);

[1] The WHO standards are available at: www.who.int/water_sanitation_health/wastewater/gsuww/en/index.html

4. Microbiological Constituents: Bacteria, Protozoa, Helminths, Viruses;
5. Chemical Constituents: Biodegradable Organics, Total Organic Carbon, Nitrates, heavy metals, pH, Trace constituents, Disinfection by-products, Total Dissolved Solids;
6. Physical properties: Total Suspended Solids, Turbidity, Temperature;
7. Monitoring: - pH, BOD, COD, TSS, Coliforms, Chlorine, Turbidity, Baseline,
8. Validation, Operation, Verification.

In the Mediterranean basin, Israel was a pioneer in the development of treated wastewater reuse practices, but was soon followed by Cyprus and Tunisia. However, the full value of treated wastewater has been recognized in relatively few water stressed countries worldwide (such as Tunisia, South Africa, Japan, China, Australia and some US states such as California, Florida and Arizona). In these countries, full fledged local or state regulations supported by national guidelines, set the basic conditions for wastewater treatment and safe reuse.

In the USA, in August 2004, national guidelines for water reuse were published as there were no federal regulations on treated wastewater reuse practices in the USA. In 2002 26 (out of 50) states had adopted regulations regarding the reuse of treated wastewater, 15 have adopted guidelines and 9 have no regulation or guidelines[1]. In the US, for the states with no specific regulations or guidelines, treated wastewater reuse projects may be permitted on a case-by-case basis.

Australia's long-term reuse experience resulted in the same conclusion as the USA, even though most Australian states had treated wastewater reuse guidelines or regulation , they decided to produce national guidelines in 2006 because: **A consistent approach to the management of health and environmental risks from water reuse requires high-level guidance. Such guidance is provided in the form of a risk management framework for beneficial and sustainable management of water reuse systems. Although these guidelines are not mandatory and have no formal legal status, their adoption provides a shared objective, and at the same time allows flexibility of response to different circumstances at regional and local levels. All states and territories are therefore encouraged to adopt the framework. However, application of the framework may vary across jurisdictions, depending on the arrangements for water and treated wastewater management** [2]. The National guidelines follow the WHO approach of risk analysis and are some of the most useful and appropriate treated wastewater reuse guidelines.

5.2 *REGULATION OF TREATED WASTEWATER REUSE IN THE MEDITERRANEAN REGION*

The following Mediterranean countries regulate the use of treated wastewater with the restrictions shown in the **Table 5.1**:

[1] USEPA 2004 Guidelines for Treated wastewater reuse EPA/625/R-04/108 August 2004 page 152 table 4-1
[2] Based on National Water Quality management Strategy. Australian guidelines for water recycling: managing health and environmental risks. Nov 2006

Table 5.1 Regulation of treated wastewater

Country	Regulation	Treated Wastewater Applications	Criteria and/or Standards
Cyprus	Provisional standards (1997)	Agricultural irrigation	Quality criteria for irrigation stricter than WHO/1989 standards but less than Californian Title 22 (TC<50/100 mL in 80% of the cases of a monthly basis and <100/100 mL always)
France	Art. 24 Decree 94/469 3 June 1994 Circular DGS/SDI.D/91/nº 51	Agricultural irrigation	Both refer to treated wastewater reuse for agricultural purposes; follow the WHO/1989 standards, with the addition of restrictions for irrigation techniques and set back distances between irrigation sites and residential areas and roadways
Israel	Regulation set by MoH	Unrestricted irrigation	There are criteria and standards for four different group of crops; Methods of treatment and setback distances are included
Italy	Decree of Environmental Ministry 185/2003	- Agriculture - non-potable urban uses -industrial uses	Possibility for the Regional Authorities to add some parameters or implement stricter regional norms
Jordan	Jordanian technical base No 893/2006	Irrigation purposes; Artificial recharge of aquifers for non-potable uses	The parameters include a variety of chemical constituents, physical properties and microbial constituents (E. coli and Helminth eggs) with a set of standard for 14 possible applications of treated water. The proposed microbiological standards range is half way between WHO and Title 22 California regulations in terms of defined use categories but not as to the standards set for each category
Malta	Guidelines applied to irrigation area supplied with treated sewage effluent. Legal Notice LN71/98 forbidding the use of wastewater for the irrigation of any crop for human consumption.	Irrigation	Criteria related to WHO standards distinguishing between crop types
Spain	Law 29/1985, BOE n. 189, 08/08/85 Royal Decree 2473/1985	Draft proposal with 14 end-use classes	Treated wastewater reuse may be practiced, yet no specific regulation followed. Draft legislation has been issued in 1999,
Regional health authorities: Andalucia, Balearic Isl. and Catalonia	Guidelines from the Regional Authorities	Up to 14 reuse classes	Regional guidelines in particular in the field of the irrigation, based on the WHO approach. Catalan guidelines are very similar to the Spanish draft but a little bit stricter for some uses.
Tunisia	Standard for the use of treated wastewater in agriculture (NT 106-003 of 1989) and list of crops that can	Agriculture	The regulation includes chemical and physical limit values as well as limit values for nematode eggs. The regulations prohibit wastewater irrigation of vegetables to be consumed raw and of heavily used pastures.

Country	Regulation	Treated Wastewater Applications	Criteria and/or Standards
	be irrigated with treated wastewater (Ministry of Agriculture 1994)		
Turkey		Agriculture	The regulation refers to several agriculture types and the technical limitations for recycling, the treatment methods for treated wastewater and suitability of industrial treated wastewaters to be used for irrigation

An overview of adopted and suggested legal frameworks in the MEDA countries can be found in the Annex to the EMWater Guide (Kramer et al 2007)

5.3 *CONCLUSIONS AND RECOMMENDATIONS*

By comparing the guidelines and regulations in force, a number of conclusions can be made:

1. Wastewater reuse is an accepted practice in Europe and the Mediterranean region and in some countries with limited rainfall and very limited water resources has become already an integral effective component of long term water resources management (e.g. in Jordan and Tunisia).
2. The majority of the Mediterranean countries along with WHO consider treated wastewater suitable for agricultural purposes and to enhance the environment
3. However, only a limited number of countries developed comprehensive water treatment and reuse standards, provide direction and encourage and finance wastewater reuse programmes. Some countries without long term planning, have adopted less comprehensive and rigorous standards in order to reflect the actual reuse practice. Often, too strict standards have led to only a few instances of legal reuse and a high number of illegal - and thus unmonitored - reuse practices in some countries.

It is clear that treated wastewater reuse plays an important and increasing role even without special European guidelines or regulations. State regulation should ensure safe wastewater reuse practices locally. However the difference in standards between EU member state regulations can cause confusion over what is best practice and sustainable for local situations and type of applications. Lack of state regulation and EU guidelines therefore are not conducive towards best practice. The EU should be in favour of setting common quality guidelines for all reuse activities whether in consideration of public health risk from irrigated crops or sports facilities, reducing the water and treated wastewater costs of manufacturing industry or increasing water availability. The existence of guidelines for treated wastewater reuse is considered crucial to overcome the barriers that discourage the development of further reuse activities. These barriers hinge over the lack of understanding of the benefits and the risk to public health and the environment whenever appropriate guidelines are not followed.

It is therefore concluded, that the establishment of EU guidelines on the safe use of treated wastewater is needed and should include the following recommendations:

1. Methods of Reuse; all the available methods related to the specific water use should be made available so as to form a multiple barrier to guarantee the quality of the recycled water.

2. Treatment; all effective technology solutions for treated wastewater reuse should be included along with their expected degree of treatment (in particular microbiological removal for bacteria, virus and parasites including protozoa) that will constitute the verification means of a satisfactory quality, comparatively with removal levels proposed by WHO 2006 guidelines.

3. Microbiological constituents; criteria and standards should be established so as to identify the most suitable indicator(s) based on evidence, and numerical values should be attributed to these, so as to guarantee the safe use in terms of public health of the treated wastewater. "Efficiency" indicators could be proposed for initial assessment of microbiological removal, and simpler "good working" indicators for following "routine" monitoring.

4. Chemical constituents; the same as for the microbiological constituents holds for the chemical constituents where depending on the use, criteria and standards should be established, source control implemented and further research to be carried out for heavy metals, hazardous substances and trace constituents. Initial and periodic (sampling strategy according to risks) receiving soil analysis for selected substances could be prescribed. Analysis of sludge of secondary treatment upstream could be an easy recording of level of environmentally dangerous substances and trace elements in effluents for reuse.

5. Physical properties; criteria and standards should be established

6. Monitoring; appropriate monitoring criteria should be selected for monitoring, so as to safeguard the result of the treatment, but also the safe quality of the media that are the final receiver of the treated wastewater.

7. Communication Strategies; the set of guidelines or regulations to be prepared, should also include communication strategies as the means to promote the use of the treated wastewater taking into consideration the negative impact on people's perceptions that usually consider treated wastewater suitable only for discharge.

8. Setback distances; it will be useful to set distances in numerical values so as to apply the precautionary principle and keep workers and users safe.

9. Responsible Ministries and Agencies should be identified to implement the regulations and to develop the sector in line with existing regulations.

10. The reference framework of guidelines for the safe use of treated wastewater should integrate the reuse for aquaculture, the reuse for wetland development as well as the reuse of treated grey water, treated excreta, and treated sewage sludge in agriculture.

11. International tourism, food production including fish/exports and transboundary river basins/ocean are strong drivers to regulate key issues of treated wastewater reuse on an international basis (Europe and worldwide). Existing international conventions have to be respected in the reference framework.

12. The widespread reuse of untreated sewage for agricultural production (with very important health risks) in Europe as well as in the Mediterranean countries is a very important subject to be regulated in a separate (more field based) “standard guideline” for irrigation with raw water on the basis of the 2006 WHO-Guideline.

13. The EU guidelines should reflect and allow adaptation to different situations in the EU and the MEDA countries with respect to existing levels of wastewater treatment, health and de facto reuse practice. In order to promote reuse in the MEDA region clear requirements for crops imported into the EU should be established.

This section presents the EU legislation related to the environment and which is linked to the concept of treated wastewater reuse[1].

6.1 TREATED WASTEWATER REUSE APPLICATIONS AND EU ENVIRONMENT RELATED LEGISLATIONS

The global framework defined through the Water Framework Directive (WFD) (2000/60/EC - WFD) establishes a legal framework to guarantee sufficient quantities of good quality water across Europe as needed for the different water uses and environmental quality.

Its key aims are:

- to expand water protection to all waters: inland and coastal surface waters and groundwater;
- to achieve "good status" for all waters by 2015;
- to base water management on river basins;
- to combine emission limit values with environmental quality standards;
- to ensure that water prices provide adequate incentives to use water resources efficiently;
- to involve citizens more closely; and
- to streamline legislation.

The use of treated wastewater should be regarded as a means of increasing water availability and can contribute to the good quality status of water resources and should therefore be considered as an option in the plans of measures to be established when implementing the WFD. Some of the mandatory steps of the WFD are very favourable for strategic reuse planning. For example, the Article 5 reports on the characteristics of the river basin district and the review of the environmental impact of human activities as well as the economic analysis of water use: this analysis constitutes a well grounded basis for identifying where treated wastewater reuse can be a useful option to be considered in the programmes of measures to achieve the environmental objectives, without compromising further economic development. Principles like cost recovery in the water pricing and public participation in water management decisions as set forth in the WFD have also been identified as essential for a successful, long-term treated wastewater reuse practice.

In this legislation, there is no explicit limitation to use a specific type of water; the only requirement concerns the achievement of quality standards defined in the directives. In addition to this global framework, there are a number of EU water-related directives requiring specific standards for specific water uses. They are listed in the **Table 6.1** below along the different reuse applications.

[1] This chapter does not include an analysis of the legislation related to health issues. All EU water-related legislation is available on http://ec.europa.eu/environment/water/index_en.htm

Table 6.1 Correlation of reuse applications and concerns or effected compartments regulated under European (water-related) directives

Reuse application	Major concern	Related directive A	B	C*	D	E	F*	G*	H*
Agricultural irrigation	Contamination of soil, groundwater and produce with chemical and/or biological hazardous substances	x	x	x	x				
	Health risk for workers and consumer								
Groundwater recharge	Health concerns if potable reuse is intended		x	x	x				
Urban applications	Health concerns regarding exposed persons								
Indirect potable reuse	Health concerns			x	x		x		
Recreational water use	Health concerns, infections risks for exposed persons					x			
Environmental enhancement	Detrimental effects on the biocoenosis						x	x	
Aquaculture	Contamination of water and produce with chemical and/or biological hazardous substances							x	X

Source: adapted from Wintgens et al. 2005 quoted in AQUAREC, 2006a[1] updated

Where:

A	Sewage Sludge Directive; 86/278/EEC	E	Bathing Water Directive; 2006/7/EC
B	Nitrate Directive; 91/676/EEC	F	Surface Water Directive; 75/440/EEC
C	Groundwater Directive; 2006/118/EC	G	Freshwater Fish Directive; 78/659/EEC
D	Drinking Water Directive 80/778/EC revised with 98/83/EC	H	Shellfish Water Directive;79/923/EEC

* to be repealed under the Water Framework Directive latest by 2013

Environmental enhancement

In general, the WFD extends controls to the inputs of all pollutants to all types of water bodies. Therefore, the general environmental objectives and the emission limit values may restrict reuse of treated wastewater of inappropriate quality. Treated wastewater reuse may be envisaged for restoration of aquatic systems, recreational or recharge purposes as long as the objectives set up for the water bodies are not compromised. Particular attention must be paid to 'protected areas', such as defined in articles 6 and 7 of WFD, mainly for sensitivity under Urban Waste Water Treatment Directive (UWWTD), vulnerability under Nitrates Directive, conservation of habitats and drinking water purposes where more stringent objectives can be defined.

In addition, the WFD clearly includes the possibility of reuse measures as stated in its annex VI part B: *'efficiency and reuse measures'* as supplementary measures *which MS within each river district may choose to adopt as part of the programme of measures required under article 11(4)*. The examples given refer to *'promotion of water-efficient technologies in industry and water-saving irrigation techniques'*.

Indeed, these measures clearly supports the general purpose of the WFD which consists in *the promotion of sustainable water use based on a long-term protection of available resource* (article 1).

Indirect Potable Reuse

The Drinking Water Directive (DWD) does not include specific restrictions with regards to treated wastewater reuse. The general obligations require that Member States take the

[1] AQUAREC, see http//www.aquarec.org

measures necessary to ensure that water intended for human consumption is wholesome and clean, which is defined through minimum requirements including microbiological and chemical parameters (article 4; Annex I). In addition, Directive 75/440/EEC sets out requirements for the quality of surface water intended for abstraction of drinking water in the Member States.

Recreational water use:

The Bathing Water Directive (BWD) concerns the management of bathing water quality and does not include restrictions regarding treated wastewater reuse. Member States are requested to take the measures to ensure that all bathing waters are at least 'sufficient' (article 5). The bathing water quality assessment is based on biological parameters (Annex I of the BWD).

Groundwater recharge

'*Artificial recharge of aquifers'* is mentioned in article 11.3 (f) of the WFD and article 6.3(d) of GWD. However, in these two directives, aquifer recharge is not defined precisely. Only the source of water is specified: *'the water used may be derived from any surface water or groundwater, provided that the use of the source does not compromise the achievement of the environmental objectives established for the source or the recharged or augmented body of groundwater.'*

The exact references to aquifer recharge in the WFD and Groundwater Daughter Directive (GWD) are the following:

- Artificial recharge of aquifer is mentioned in the WFD; annex VI, part B (xiv) as a possible supplementary measure to be adopted as part of the Programme of measures required under article 11(4). However, 'prior authorisation of artificial recharge' is required, as well as 'periodical controls' as specified in Article11.3 (f) of the WFD.
- In addition, the GWD mentions in its article 6 that exemptions[1] concerning aquifer recharge is possible, provided that 'efficient and appropriate monitoring' is being carried out and 'without prejudice to any more stringent requirements'. Such more requirements could for instance apply where the recharge might affect a Natura 2000 area or drinking water production.

As a conclusion, artificial recharge with treated waste water is not explicitly excluded by the WFD or by the Groundwater Daughter Directive (GWD); therefore aquifer recharge may be implemented as far as Member States are taking the following measures:

- permit or authorisation; and
- control / monitoring.

More generally, the regime of protection for groundwater refers to the existing Groundwater Directive 80/68/EEC, which requires that Member States take the necessary measures, including a special authorisation system, to *prevent* "List I" substances from entering groundwater, and to *limit* the entry of "List II" substances so as to prevent pollution of the groundwater. This directive will be repealed in 2013 under the WFD, and its provisions are taken over by Article 6 of the GWD.

Pursuant to WFD Article 22(2), Directive 80/68/EEC will be repealed in December 2013, but the level of protection established by 80/68/EEC should be pursued and strengthened under

[1] Exemption concerns the measures that Member states are requested to implement in order to prevent or limit the inputs of pollutants into groundwater

the WFD and GWD. The GWD includes criteria for assessing good groundwater chemical status and for identifying significant and sustained upward trends and starting points for trend reversals. One element that is also included is a framework for making the WFD 'prevent or limit' objective operational. This clarifies which substances shall be prevented from entering and which shall be limited in groundwater, and also exemptions from this prevent or limit objective.

A number of detailed recommendations on 'direct and indirect inputs' in the context of the GWD are available in a guidance document n°17[1].

In addition to the chemical status objectives of the WFD, groundwater has also to be protected as a drinking water resource under Articles 6 and 7 of the WFD. In this context, groundwater bodies used for the abstraction of water intended for human consumption have to be delineated as protected areas (Article 6 WFD) and protected in such a way as to ensure compliance with Article 7 of the WFD. This stipulates, in particular, that the necessary protection for bodies of water has to be ensured with the aim of avoiding deterioration in their quality in order to reduce the level of purification treatment required in the production of drinking water. The resulting water has hence to meet the requirements of Directive 80/778/EEC as amended by Directive 98/83/EC. This means that quality controls related to water reuse operations have also to consider microbiological contamination risks and not only pollution by chemical substances
Details are available in the Guidance document CIS n°16[2] on "Groundwater in Drinking Water Protected Areas".

6.2 *TREATED WASTEWATER REUSE AND THE EU EMISSIONS RELATED LEGISLATIONS*

In addition to the directives related to specific water uses, the EU legislations related to the production of 'waste' water can also be of interest for identifying if there are limitations as regards the reuse of these effluents. **Table 6.2** below summarises the existing EU legislations.

Table 6.2 Existing EU Legislation

Treated wastewater production	Water-related legislation on emissions
Agriculture	Nitrates directive
Urban	UWWTD
Industrial	IPPC

Agriculture

Treated wastewater reuse can support the achievement of the objectives of the Nitrates Directive. The aim of the Nitrates directive (91/676/EEC) is to protect water against pollution caused by nitrates from agricultural sources. It contains provisions for the designation of vulnerable zones and for action programmes for such zones (including global nitrogen balance to ensure equilibrium between nitrogen application with fertilisers and crop uptake in fertilisation practices (Annex III, 1, 3). The soil application of organic nitrogen coming from treated wastewater reuse (this could represent a significant fraction of the total nitrogen

[1] Guidance document n°17 guidance on the application of the term 'direct and indirect inputs' in the context of the Groundwater directive 2006/118/EC, see website:
http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/guidance_documents/guidance_document/_EN_1.0_&a=d

[2] guidance document CIS n°16 on "Groundwater in Drinking Water Protected Areas" :
http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/guidance_documents/groundwater_dwpaspdf/_EN_1.0_&a=d

application) shall be considered in order to ensure a balance between N crop demand and N supply from various sources. Monitoring of nitrogen contents in reclaimed treated wastewater used for irrigation in vulnerable zones is crucial to avoid over-fertilization Measures to prevent nutrient pollution from runoff and downwards water movement in irrigation have to be put in place[1].

Urban

The Urban Wastewater Treatment Directive (91/271/EEC- UWWTD) concerns the collection, treatment and discharge of urban wastewater and the treatment and discharge of wastewater from certain industrial sectors. Its main objective is to protect the environment from the adverse effects of these discharges. As regards treatment it sets up limits for concentration (or percentages of reduction) for some pollutants in the discharged effluent (as a function of the size of agglomerations and of the sensitivity of the receiving waters). Frequencies for sampling and allowed sampling failure rates are described as well.

In Article 12 it states that "*treated wastewater shall be reused whenever appropriate*". The term "appropriate" means that reusing treated wastewater is possible as far as it is not forbidden or restricted by any other EU legislations, does not compromise the implementation of international commitments or does not affect the achievement of the objectives set up in other EU legislation, not only environmental. In addition, flexibility is left to the appreciation of Member States on a case by case basis.

Industrial

The Integrated Pollution Prevention and Control (IPPC) Directive (96/61/EC) sets out requirements on the operation of a range of activities listed in the Annex I of the directive in order to ensure a high level of environmental protection in particular to prevent or reduce emissions in the air, water and land. According to the Directive, IPPC installations have to operate according to permit conditions based on Best Available Techniques (BAT). The BAT Reference Documents (so-called BREFs) adopted by the Commission set out what is considered BAT at EU level.

To complement the WFD a directive on environmental standards for Priority substances[2] is being discussed (Article 16). The proposed Directive[3] sets harmonised and ambitious quality standards for 41 (groups of) chemicals. It also reviews the selection of priority hazardous substances and repeals several daughter directives from the 1980's that regulated similar issues. It does not address pollution control measures since they are covered by separate legal instruments such as, for example, Registration, Evaluation, Authorisation, and Restriction of Chemicals (REACH), the IPPC Directive (integrated pollution prevention and control) and the Thematic Strategy on pesticides and mercury which are currently under negotiation.

6.3 OTHER RELEVANT EUROPEAN ENVIRONMENTAL LEGISLATION

Other European legislations that are directly or indirectly linked to treated wastewater reuse include:

[1] see Annex II, point B.10 of the Nitrates Directive

[2] Chemicals of EU-wide concern which cause pollution of surface waters.
[3] Proposal (COM (2006)397 final) of 17 July 2006

- Landfill Directive (99/31/EEC): This concerns the waste landfills. It aims to provide measures, procedures and guidance to prevent or reduce as far as possible negative effects on the environment,

- EU-Regulation concerning the REACH, establishing a European Chemicals Agency and amending Directive 1999/45/EC: This Regulation provides a structure to evaluation substances being brought into the EU-market and provides adequate information for users, and authorities. This Regulation is based on the principle that it is up to manufacturers, importers and downstream users to ensure that they manufacture, place on the market or use such substances that do not adversely affect human health or the environment. Its provisions are underpinned by the precautionary principles. Protection of water is included in the evaluation of substances by manufacturers and other relevant organisations. REACH leaves the WFD/GWD and the relevant authorities to evaluate substances (as such or in products) with regard to protection of water in general or in specific situations.

- Environmental Liability Directive (2004/35/EC): This Directive is based on the polluter pays principle; it establishes a framework to prevent and remedy environmental damage (water, soil and biodiversity).

- Soil directive: the draft soil directive (negotiated in 2007) focuses on soil protection; Processes such as erosion and "sealing" will have to be monitored, action plans will have to be written and, if necessary, measures will have to be taken. Also soil contamination (including the prevention, the detection of contamination and the remediation) is included. The introduction into soil of dangerous substances should be limited (Article 9). In case of large spreading on soil, the quality of the treated wastewater has to be appropriate and should not hamper soil quality and soil function.

- Habitats Directive (92/43/EEC) - indirectly protects groundwater, in particular quantity. The requirement to maintain groundwater fed habitats implies safeguarding groundwater flow in these areas.

- Strategic Environmental Assessment (SEA) and Environment Impact Assessment (EIA): To devise methods and environmental tools to analyse the impact of proposed development, the Directive on Environment Impact Assessment for projects and the Directive on Strategic Environmental Assessment for plans and programmes are the two main tools used in this task. These make sure significant environmental impacts are identified, assessed and taken into account throughout the decision-making process. They concern water-and treated wastewater related actions. In particular, Annexe 1.11 of the EIA directive concerns artificial groundwater recharge schemes where the annual volume of water abstracted or recharged is equivalent to or exceeds 10 million cubic metres

The majority of the above mentioned legislation is listed in Part A of Annex VI of the WFD as being part of its "basic measures" which Member States have to implement to achieve the objectives of the WFD. These directives are therefore complementary to the WFD, and their requirements must still be carried out. If the requirements within these existing directives are not on their own sufficient to achieve the objectives of the WFD, then Member States must carry out supplementary measures.

As a conclusion, the EU existing legal framework related to the Environment does not include any specific text on treated wastewater reuse. However, the provisions described above provide the framework for implementing treated wastewater reuse along the EU environmental standards, and would greatly benefit from common treated wastewater reuse guidelines.

6.4 CONCLUSIONS

Treated wastewater reuse for environmental and economic reasons must consider the requirements set out by EU environmental policy (in particular in Water Framework Directive 2000/60/EC). Existing environmental legislation in Europe refers directly and indirectly to the benefits of treated wastewater reuse as an alternative supply of fresh water for a number of applications where potable quality is not required. To ensure a high level of protection, the requirements of the respective legislations must be met, particularly where authorisations and monitoring is concerned. Furthermore, levels of pollutants in treated wastewater must be reduced to safe levels as determined through a risk management approach and, where appropriate, through the application of best available techniques (BAT) where the Integrated Pollution Prevention Control legislation applies as referred to in the BREF documents (Best Practice Reference Documents). In cases where conventional BAT proves insufficient to achieve binding environmental objectives, then MS shall seek to apply additional measures prior to authorising treated wastewater reuse.

In this context therefore, EU and Mediterranean countries would benefit from common guidelines that are based on good practice and supported by a dynamic knowledge exchange network that promotes appropriate, safe and sustainable good practice

7 ECONOMIC ISSUES

7.1 INTRODUCTION

Any economic and financial aspects of treated wastewater reuse will need to take into account the existing economic background conditions given by the conventional water market. The question arising is whether and how treated water can be placed in this market as a new product or common good. The intent of this chapter is to highlight some important economic issues with regards to treated wastewater reuse activities and provide some examples.

The real value of water is not necessarily associated with its price or cost but what it does to enhance the environment, economy and quality of life of the general population. Economic and financial issues are crucial, as less viable schemes for treated wastewater reuse will only create a social burden and will not be a sustainable benefit. Cost-effectiveness, economic benefit analysis, Financing policies, and user participation should be given high priority.

7.2 THE COST OF WATER SCARCITY AND POLLUTION CONTROL

The EU Water Scarcity and Drought working group estimated that the overall economic impact of drought events in the last 30 years at the EU level was around €100 billion. Results show that the annual average impact has doubled between 1976-1990 and 1991-2006. It reached an average of €6.2 billion per year in the last few years, with an exceptional cost of €8.7 billion in 2003. If the EU had achieved a 20% treated wastewater reuse target for irrigation to reduce water scarcity in Europe, this could have reduced the economic impact of drought in the EU by € 20 billion in the last 30 years. These estimations only cover economic costs and do not include social and environmental costs due to a lack of data.

Furthermore the costs to control water pollution accounts for about 0.8 % of GDP in several EU Member States and has absorbed more than 50 % of all environmental investment in recent decades. If water pollution is not managed wisely, it can crowd out other important environmental investment needs. Implementing the UWWTD will require a greater emphasis on eco-efficiency, and economic incentives that promote wastewater reduction.

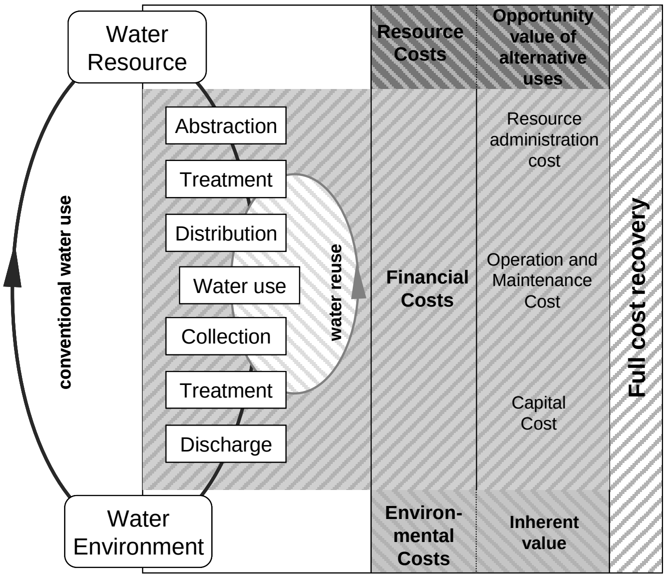
7.3 THE NATURE OF COST RECOVERY FOR WATER SERVICES

The price that customers pay for water is a government regulated decision based on the political, social, environmental and economic priorities. Under priced water resources can create an artificial demand for water in urban and industrial as well as agricultural uses.

The WFD policy is to achieve Full Cost Recovery (FCR) in the price charged for water services in the EU. This takes into account the environmental and resource costs associated with damage or negative impact on the aquatic environment. Whereas financial costs can be determined exactly, the estimate for resources and environmental costs is much more difficult. Methods to do so are currently being developed in the Common Implementation Strategy for the Water Framework Directive (CIS). To date, water prices at best reflect the financial cost of providing and administering water services including all operation and maintenance costs, and capital costs. Even then only a few EU member states achieve (financial) cost recovery of their water service provision (e.g. England and Wales, Germany and the Nordic countries) (Aqualibrium, 2003).

Figure 7.1 attributes these different cost components to the individual steps along the anthropogenic water cycle, involving abstraction, treatment, use, collection, purification and discharge. It is of vital interest for the promotion of treated wastewater reuse to put a value to these unaccounted externalities. The diagram also shows that treated wastewater reuse may bypass the water environment compartment and in consequence the possible environmental and resource cost.

Figure 7.1 The idea of full-cost recovery - water use and associated cost types according to the Water Framework Directive



Source: Hochstrat et al., 2007

However, the tariffs or costs of water services do not capture the real value of water. The economic value of water (the beneficial value created through the quality and availability of water) should also be based on environmental, social and economic benefits using whole life, environmental sustainability and cost effectiveness tools. Data on such economic externalities of treated wastewater reuse is still lacking. There is a need to develop the methodology to measure the economic value of treated wastewater. WFD requires each river basin district to undertake the economic analysis of water uses – the main objective is to assess how important water is for the economy and socio-economic development of the river basin district. The analysis should pave the way for the identification of significant water uses (to be reported to the public by 2007) and the cost-effectiveness analysis by initiating investigations of likely tradeoffs between socio-economic development and water protection.

The value of wastewater reuse can depend on water availability at a given time and place. The economic value of treated wastewater in a sectoral application can be assessed by the corresponding conventional water price or the added value generated by the specific sector. The economic analysis (according to Art. 5 WFD) should regard water as a production factor such as material, work, energy, etc. and hence be able to put a figure to the value of (reclaimed) water. For example, Global Water Intelligence (GWI) states that **water used in**

certain industries generates output 70 times more valuable than one cubic metre of water used in agriculture[1].

Treated wastewater reuse can then be deployed as a tool to achieve a more efficient allocation of water resources: for example substituting the use of potable quality water for lower quality treated wastewater where potable quality is not required (potable substitution). The concept of Full Cost Recovery (FCR) is recommended for the evaluation of treated wastewater reuse applications as it includes the beneficial environmental effects.

7.4 *THE LIFE CYCLE COST ANALYSIS (LCC)*

Life Cycle Cost analysis is a useful way to evaluate the conditions under which treated wastewater reuse can be cost effective and in comparing cost performances of different collection and treatment technologies and investment strategies. The cost estimates include the cost of a product over its entire lifespan, from the cradle to grave, including capital costs, annual operation and maintenance costs. Total treated wastewater life cycle cost is converted to €/m^3 (by dividing the estimated life cycle cost, €/yr, with the treatment facility capacity, m^3/yr). Treated wastewater system costs are a function of facility capacity, end-use application and water quality requirements for each reuse alternative. A range of costs estimated by Asano (1998) are presented in **Table 7.1** below.

Table 7.1 Summary of Cost Wastewater Treatment Cost Estimates

Reuse alternative	Recommended treatment process	Annual costs (€/m^3)a, b
Agriculture	Activated sludge[2]	0.16-0.44
Livestock	Trickling filter	0.17-0.46
Industry and power generation	Rotating biological contactors	0.25-0.47
Urban irrigation – landscape	Activated sludge, filtration of secondary effluent	0.19-0.59
Groundwater recharge – spreading basins	Infiltration – percolation	0.07-0.17
Groundwater recharge – injection wells	Activated sludge, filtration of secondary effluent, carbon adsorption, reverse osmosis of advanced wastewater treatment effluent	0.76-2.12

Source: Asano, 1998; (a): Costs are estimated for facility capacities ranging from 4,000 to 40,000 m3/d. Lower cost figure within each treatment process category represents cost for a 40,000 m3/d reclamation plant while the upper cost limit is presented for a 4,000 m3/d facility, (b): Annual costs include amortized capital costs based on a facility life of 20 years and a return rate of 7 %.

The case studies in **Annex B** include the following cost examples for advanced treatment (MF/UF –RO): Torrelle Flanders. 0.45 €/m^3 (Capital, operation & maintenance) and Orange Country Water District, CA. 0.39 US$/$m^3$ & 50% less energy than importing water. Energy is one of the highest costs and the Costa Brava case study gives a detailed table for different applications.

[1] Global Water Intelligence. Desalination Markets 2007. P15. www.globalwaterintel.com

[2] Could also be natural low-cost treatment systems such as stabilisation ponds, constructed wetlands, or other like trickling filter, rotating biological contactor (Kramer et al 2007, Wendland et al 2006, WHO 2006)

7.5 *Economic Incentives for Wastewater Reuse*[1]

As the analysis in Chapter 4 revealed most treated wastewater reuse activities are driven by water stress and water scarcity, which in turn strive for efficiency in terms of both allocation and more rational use of water. While treated wastewater reuse is justified by social and environmental aspects, the reality of the situation is that its use must be encouraged in relation to the bulk of available resources. The following section discusses the possible incentives for treated wastewater as alternative resource.

While undertaking wastewater treatment projects is fully justified in terms of objectives, it is not always possible to defray its costs by charging tariffs. In fact, totally recovering costs by these means would imply a high willingness or ability to pay. Again an issue arises which centres on the question of who is paying what (on basic principle that the user and the polluter has to pay). Is it justified that only the user of treated wastewater has to cover the costs for the upgrade of treated wastewater and distribution? Or should all beneficiaries (including users of conventional water resources) contribute to the coverage of costs?

In the case of groundwater recharge the beneficiary is either the "owner" of the groundwater (i.e. in most cases the state) or the one who has been granted the access rights to the resource. Depending on the purpose of the artificial recharge (salt water intrusion barrier, temporary storage before re-abstraction, or combined uses) the beneficial effects materialise for different parties who should take their portion of the cost. It is characteristic for many reuse applications that they do not have a personified user who directly pays in exchange for the product.

7.5.1 *Pricing treated wastewater*

Marginal cost pricing can reduce excessive water use and pollution as well as ensure the sustainability of wastewater treatment programmes. Setting appropriate tariffs for treated wastewater provides an important incentive mechanism to encourage its reuse. This may include:

- **No charging -** Treated wastewater charged at a zero tariff so as to increase its demand and therefore reduce or avoid effluent discharge into sensitive aquatic environments. For example, some schemes in Australia with the aim to avoid or reduce effluent discharge into sensitive aquatic environments do not charge at all for treated wastewater reuse (WSAA, 2005).

- **Defined percentage of the potable water price** - Treated wastewater reuse is often offered for a lower price than potable water. This price signal highlights the advantages of wastewater reuse for the customers and increases its acceptance. A few examples include: a 2005 survey of 11 southern Californian wastewater reuse projects mostly supplying irrigation water showed a treated wastewater price as a percentage of potable water prices ranging from 45 to 100% with an average of 77%. (APWA 2005); Sydney Water provides treated wastewater for domestic uses in the Rouse Hill residential area for only 30% of the potable water price. Sydney Water has proposed price increase by 2009 from the current 30% of potable water price to 80% to reduce overuse and wastage (Sydney morning Herald July 2006); and in Sydney Olympic Park the price is fixed at AUS$ 0.15 below the drinking water price (AATSE, 2004, SOPA, 2006). Another simpler and more operative possibility is to set an arbitrary percentage of the price of drinking water as a rate for treated wastewater, in light of the fact that the latter is lower quality (e.g. in Durban**, t**he

[1] From AQUAREC (2006) Report on integrated water reuse concepts. Deliverable D19, Eds. T. Wintgens and R. Hochstrat (www.aquarec.org)

price for reclaimed water for industry is more than 25% cheaper than potable water - case study **Annex B**)

- **Price adjusted to the willingness to pay of users** - From a demand viewpoint, knowing how much, different users would be willing to pay for the treated wastewater is important Under this premise, rates for treated wastewater would be based on what the market could uphold, without taking into account the costs required. That is, the aim would be to charge users the value they assign to treated wastewater. The willingness to pay for different customers varies depending on the expected economic return. Moreover an increased awareness of the benefits of wastewater reuse amongst the public can lead to increased demand and also induce consumers to state a higher willingness to use and willingness to pay.

- **Same prices for conventional and treated wastewater** - In this case there is no differential in prices been conventional and treated wastewater. For example in Cyprus, some schemes started selling recycled water for agricultural irrigation at the same price as farmers paid for conventional freshwater, i.e. € 0.1 EUR/m³ As the implementation of the price reform will further increase prices for conventional irrigation water to € 0.20, treated wastewater will become even more competitive (Hidalgo, 2005).

Finally, it is important to assure a suitable relationship between the rates for conventional resources and treated wastewater prices. Setting an excessively low price for treated wastewater in relation to existing alternatives could over-encourage the use of this water, provoking unsuitable uses and even external costs. A solution to this is the use of an increasing block tariff - stepped increases in tariffs as usage increases.

Table 7.2 gives a few examples of the prices for conventional water and treated wastewater

Table 7.2 Examples of Tariffs for conventional and treated wastewater

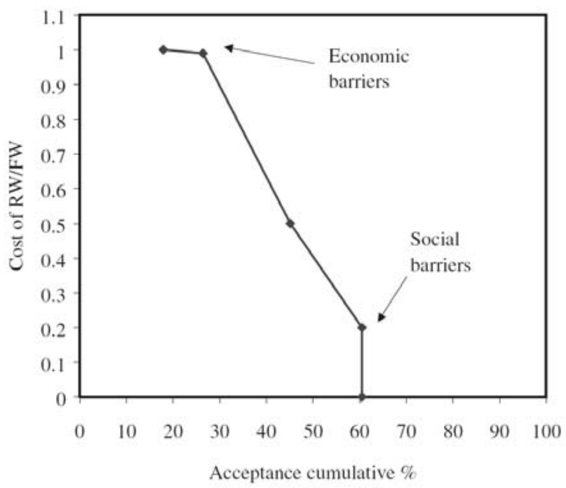
Scheme	Use	Conventional	Treated WW	%
Sydney Olympic Park, AUS	Domestic / Urban (Irrigation)	1.20 AUD (up to 1,100 m³/d)	1.05 AUD	88 %
		1.48 AUD (> 1,100 m³/d)		71 %
Rouse Hill, Sydney, AUS	Domestic	1.20 AUD (up to 1,100 m³/d)	0.293 AUD	24 %
		1.48 AUD (> 1,100 m³/d)		20 %
Noirmoutier, FR	Agricultural irrigation	1.54 EUR	0.23 - 0.30 EUR	15 – 20%
Cyprus	Agricultural irrigation	0.1 EUR	0.1 EUR	100 %
Israel	Agricultural irrigation	0.31 USD (planned increase)	0.12 USD	39 %

7.5.2 *The use of subsidies*

In essence, fixing the price for treated wastewater is always a trade-off of cost distribution between the beneficiaries, the operators and the tax payer in general. Subsidies are seen as an important incentives mechanism and are commonly applied to promote a desired behaviour. Comparing the users' or beneficiaries willingness to pay with the real cost of a planned measure can give a first indication about the viability of the activity or the necessary degree of subsidisation (Karkanakis *et al.*, 2005). Thus, investment subsidies can cover the difference between the total cost of the project and the amount that can be defrayed by those who benefit from it. For example, treated wastewater reuse for agricultural in Israel is highly subsidised. The Israeli State fully pays for the conveyance and storage of treated wastewater and also takes over the cost for upgrading wastewater to a high quality level. The users (farmers) are only charged the cost for 'low level treatment' suitable for restricted irrigation, 0.098 EUR/m³. This subsidisation is less costly than treating wastewater to a quality suitable for discharge into surface waters (Fine et al, 2006). In Italy, Art. 155(6) of the Legislative Decree 152/2006 orders that tariffs for industrial users have to be discounted to promote wastewater reuse for productive activities as a function of the volume of the reused water and of the quantity of fresh water used.

Tsagarakis and Georgantzis (2003) showed that subsidised prices for treated wastewater can be applied effectively in order to expand the adoption of wastewater reuse (see **Figure 7.2**). Amongst the farmers under investigation the willingness to use treated wastewater was strongly economically motivated as it depended on the price difference between conventional and treated wastewater. Nonetheless acceptance could not be broadened to all potential users as there are limitations marked by economic barriers (too little incentive) and by social barriers indicating a principal rejecting attitude. Moreover they found that additional information about benefits and risks of wastewater reuse and on experiences in other countries could positively influence the target group's attitude towards applying treated wastewater for their own purposes.

Figure 7.2 Demand curve for treated wastewater: relation of acceptance and cost ratio



Source: Tsagarakis and Georgantzis, 2003

Even if subsidies might subsist in the regular water market they should at least be targeted more wisely in order to act towards the achievement of e.g. WFD objectives. Subsidising irrigation water might be environmentally more detrimental than subsidising agricultural produce. In view of the actual low cost recovery in the irrigation sector, farmers' willingness and capability to pay for water is not yet fully developed. Massarutto (2002) found that in Italy the exit price (abandoning irrigation) lies between € 0.05 and € 0.15 /m³ for open air crops (cereals and oilseeds). For Mediterranean products (olives, citrus) it is even higher (up to €1.50 /m³) although associated to some erosion of the gross margin, but also to a more profitable allocation of the water resource. Such figures should be kept in mind when discussing the feasibility of reuse projects and the possible price of treated wastewater.

7.5.3 *Indirect incentives*

Indirect incentives such as for instance effluent charges, surface or groundwater abstraction taxes can also encourage wastewater reuse:

- Abstraction taxes are becoming very common, but rarely are the fees high enough to significantly influence behaviour and encourage the user to move from a freshwater resource that is often of very high quality, to treated wastewater. However in some parts of Northern Europe it is economically justifiable to reuse industrial wastewater based on cost savings in potable, groundwater or surface water abstraction and wastewater heat recovery and discharge charges.
- Effluent charges are also increasingly applied throughout the Union. In Germany, for instance, the charge per pollutant has been raised in several steps, increasing by approximately 600% from 1981 when it was introduced - to 1997, and it is now at about 5% of the total cost. In addition, certain investments for the improvement of wastewater handling can be offset against the charge.

7.6 SUMMARY AND CONCLUSIONS

- According to the EU Water Scarcity and Drought working group the overall economic impact of drought events in the last 30 years at the EU level was around €100 billion. If the EU had achieved a 20% wastewater reuse target to reduce water scarcity in Europe this could have reduced the economic impact of drought in the EU by €20 billion in the last 30 years.

- The costs to control water pollution accounts for about 0.8 % of GDP in several EU Member States and has absorbed more than 50 % of all environmental investment in recent decades. If water pollution is not managed wisely, it can crowd out other important environmental investment needs.

- Implementing the UWWTD will require a greater emphasis on eco-efficiency, and economic incentives that promote wastewater reduction.

- The WFD policy is to achieve Full Cost Recovery (FCR). This takes into account the environmental and resource costs associated with damage or negative impact on the aquatic environment; however, to date, water prices at best reflect the financial cost of providing and administering water services including all operation and maintenance costs, and capital costs.

- The economic value of water is not necessarily associated with its price or cost but what it does to enhance the environment, economy and quality of life of the general population. Data on economic externalities on treated wastewater reuse is still lacking and more effort is needed to measure the true economic value of treated wastewater reuse. The economic value of treated wastewater in a sectoral application can be assessed by the corresponding conventional water price or the added value generated by the specific sector. The economic analysis (according to Art. 5 WFD) should regard water as a production factor such as material, work, energy, etc. and hence be able to put a figure to the value of treated wastewater. Wastewater reuse can be less costly than using freshwater.

- Life Cycle Cost analysis is a useful way to evaluate the conditions under which treated wastewater reuse can be cost effective and in comparing cost performances of different technologies and investment strategies.

- Setting appropriate tariffs for treated wastewater provides an important incentive mechanism to encourage its reuse.

- In essence, fixing the price for treated wastewater is always a trade-off of cost distribution between the beneficiaries, the operators and the tax payer in general.

- Subsidies are seen as an important incentives mechanism. Comparing the users' or beneficiaries willingness to pay with the real cost of a planned measure can give an indication about the viability of the activity or the necessary degree of subsidisation. Subsidies can also be applied to promote a desired behaviour.

8 KEY RECOMMENDATIONS

The key recommendation of the MED EUWI Wastewater Reuse Working is to develop a commonly agreed European and Mediterranean guidance framework for treated wastewater reuse planning, water quality recommendations, and applications. This framework would provide a consistent approach to the management of health and environmental risk. Although not mandatory and having no formal legal status, the framework would provide a shared objective while allowing flexibility of approach to different circumstances at national, regional or local level.

We recommend that the guidance framework should include:

- The definition of the appropriateness of treated wastewater reuse for social, economic and environmental good practice.
- The ways in which treated wastewater reuse can improve policy implementation while helping to achieve the WFD and MDG objectives in the face of climate change.
- Agricultural, landscape, irrigation and other application guidelines to provide a common level of public health protection in the EU MED region.
- Summary of all proven techniques and technology solutions and their respective costs. This would include inexpensive solutions for poor rural communities to help achieve the MDG.
- Assessment of the non-environmental EU legal framework related to treated waste water reuse (inc. food safety)
- Detailed analysis of the economic, energy, and climate change adaptation and mitigation impacts of existing projects.
- Educational programme on the benefits of reuse, adaptation and mitigation opportunities, community and stakeholder involvement good practice and the creation of a sustainable knowledge exchange network.
- Lessons learned from existing facilities in the EU Mediterranean leading to improved information on the economical and financial benefits (volumes and percentage of treated wastewater reused, approximate benefit to the economy with number of employees in the reuse industry, capital expenditure, export values achieved per annum).

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