Service contract for the support to the follow-up of the Communication on Water scarcity and Droughts

UPDATED REPORT ON WASTEWATER REUSE IN THE EUROPEAN UNION

April 2013

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1. INTRODUCTION

With climate change, population growth and water scarcity, there is a growing need to manage water resources in a sustainable manner. Worldwide, there is an increased pressure on the world's freshwater sources. Many large rivers, particularly in semiarid regions, have significantly reduced flows and the abstraction of groundwater is unsustainable, resulting in declining water tables in numerous regions. Therefore, the use of recycled water has become an increasingly important source of water. Water-recycling projects for non-potable end uses are a common practice with more than 3,300 projects registered worldwide.

Almost all Mediterranean countries in the EU regularly experience severe water supply and demand imbalances, particularly in the summer months. This is due to the simultaneous occurrence of low precipitation, high evaporation and increased demands for irrigation and tourism. However, this situation have been extended to other regions water, when periods of drought are becoming more frequent and long lasting as a result of global climate change. France, Bulgaria, Malta, Belgium, and the UK have suffered the negative impact of successive droughts over the last twenty years.

Several strategies have been implemented to face these shortage events of drought and scarcity. Some solutions can be implemented such as water savings (e.g. reducing the leakage from supply networks, using more efficient irrigation techniques such as drip irrigation and small flush toilet systems), tapping other resources (e.g. desalinating seawater or brackish water) and diversification of wastewater reuse practices.

Treated wastewater reuse can have many important benefits. The most obvious is the provision of an additional dependable water resource. The second is the reduction of environmental impacts by reducing or eliminating wastewater disposal, which results in the preservation of water quality downstream. Therefore, in the framework of an integrated water management strategy at a catchment's scale, the benefits of wastewater reuse should always been assessed taking into account that water recycling and reuse contributes to both enhancing a region's water resource and minimizing wastewater outflow. In addition, using recycled wastewater for irrigation can reduce the need for fertilizer thanks to the nutrients it contains. This may even remove the requirement for tertiary wastewater treatment in sensitive areas that is stipulated by the Urban Wastewater Treatment Directive.

Amongst all the applications that treated wastewater could have, crop and landscape irrigation, industry, fire-extinction, aquifer recharge and urban non-potable use are the most considered. As for the potable reuse, a lot of work needs still to be done.

Following the report 'Update of the Final Report on 'Water reuse in the European Union', delivered in April 2012, this report aims to gather the precise state of art for each country that conforms the European Union, considering the registered data, legislation, management policies, financial incentives and Research and Development projects to the date. Furthermore, some of the main data gaps detected during the research are listed so they can be worked out in a close future.

2. CURRENT SITUATION ON WASTEWATER RE-USE

2.1. FALKENMARK WATER STRESS INDEX IN THE EUROPEAN COUNTRIES

The Falkenmark indicator is perhaps the most widely used measure of water stress. It is defined as the fraction of the total annual runoff available for human use. Multiple countries were surveyed and the water usage per person in each economy was calculated. The Water Stress Index of all the members of the European countries are shown in Figure 1 below:

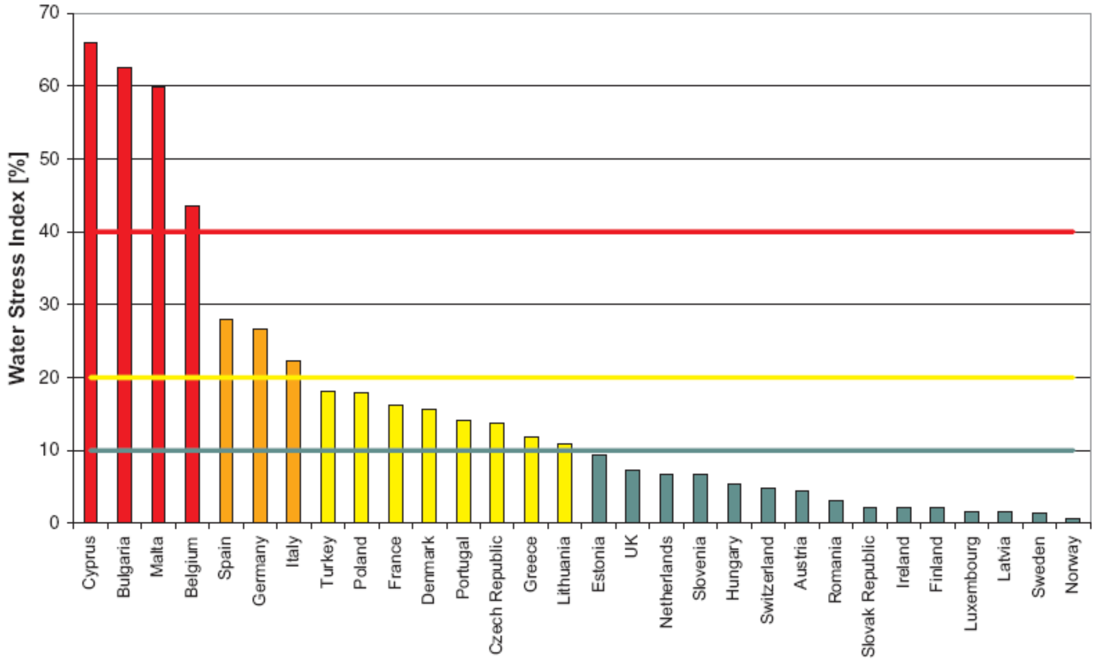

Figure 1 Water stress index % (abstraction/availability ratio) WSI below 10%: low; WSI from 10% to 20%: moderate, WSI from 20% to 40%: high and WSI above 40%: severe.

In regions that suffer from water scarcity, water resources are exploited to their maximum safe capacity (or beyond). Thus, the stored volumes of both groundwater and surface water are becoming smaller, which leads to shorter retention times. This is generally followed by deterioration of water quality by pollution. Wastewater reuse practice contributes to the enhancement of the quality of conventional water resources by reducing the pressure on the conventional resources, resulting in larger water bodies and longer retention times and eliminating one of the main sources of pollution: municipal sewage.

In water abundant regions, the negative effect of pollution may be reduced by dispersion of pollutants in large water bodies where longer retention times facilitate degradation of some of the pollutants. It should be emphasized, however, that the negative effects are reduced, but not eliminated. In these regions, wastewater reuse contributes to the sustainability of the urban sector in several aspects, including the alleviation of the stress on conventional water resources, the reduction of the quantities of water that have to be conveyed over longer and longer distances and the reduction of the pollution caused by effluents released to the aquatic environment.

It is, then, to be expected, that the countries with higher WSI are more conscious of the need of reclaimed water, and therefore, their law implementation and projects development on the subject are in an advanced state.

2.2. TRENDS OF SECTORAL WATER USES IN EUROPE

In the table below, the sectors in which reclaimed water is currently applied on by country are shown:

	Agriculture	Municipal	Potable Unplanned Indirect Reuse	Groundwater recharge	Industrial	Environment	Future Plan	Desalination	Regulations / Guidelines
Austria					x				No
Belgium	x		x	x	x		x		Under prep.
Bulgaria					x		x		Under prep.
Cyprus	x	x		x	x	x	x	x	D 296/ 03.06.2005
Czech Republic									No
Denmark					x		x		No
Estonia					x		x		No
Finland					x				No
France	x	x	x	x	x		x	x	D 94/463.3.1994 DGS/SD1.D.91 Guidelines 1996
Germany	x	x	x	x	X	x	x	x	Under prep.
Greece	x				x		x	x	JMD 145116/11 GG B' 192/1997
Hungary							x		96/2009 (XII. 9)
Italy	x	x		x	x		x	x	D152/2006
Ireland							x		No
Latvia							x		No
Lithuania							x		No
Luxembourg					x		x		No
Malta	x	x			x		x	x	Under prep.
Netherlands		x			x	x	x	x	No
Poland							x		Under prep.
Portugal	x	x	x	x	x	x	x	x	RecIRAR 2/2007 ERDAR Guideline
Romania									No
Slovakia									No
Slovenia							x		No
Spain	x	x		x	x	x	x	x	RD 1620/2007 Guidelines from the Regional Health Authorities
Sweden	x			x	x		x		No
UK		x	x	x	x	x	x	x	Under prep.

Table 1.Available information with respect to the reclaimed water is given by countries.

The sectoral profile of water abstraction is expected to change in the long term: industrial water use is likely to stabilise or even decrease; in Eastern Europe, urban water supply may grow significantly; agriculture is expected to remain the largest water user in the Mediterranean countries, with more irrigation and warmer and drier growing seasons resulting from climate change.

2.2.1. Agriculture use profile

In spite of the declining importance of agriculture in the economy of European countries, agriculture still is a very important economic sector in many European countries. Agriculture represents the highest consumptive water use (55%). Irrigation is the most significant use of water in agriculture, being almost 100 %, since livestock consumption is around 0.6%.

The volume of irrigation water depends on climate, the crop being cultivated, the area being irrigated and the irrigation method. Therefore, sharp differences on the portion of irrigated land out of the total agricultural land are observed in Europe: virtually nil in some northern and central countries like Lithuania and Switzerland to 60% in the Netherlands. In the southern countries the parcel of irrigated land is a smaller percentage of the total agricultural land (38% in Greece, 18% in Spain). Nevertheless, in Southern European countries water for agriculture rises to 73% of consumptive uses and 62% of total uses. Greece, Spain, Italy, Portugal, Denmark and Romania are the countries that consume higher percentage of water for irrigation.

It is difficult to foresee the pattern of water use in agriculture in Europe in the future. The Common Agriculture Policy (CAP) and its reforms present a major influence on agriculture water use. The CAP reform in 1992 reduced production and led to the use of more efficient irrigation methods. As a consequence, water for agriculture decreased during the 1990s in the southern western countries. However, since 2002, an increase of water for agriculture is observed in the member states of South eastern Europe (Romania, Bulgaria, and Hungary). In addition, CAP will no longer subsidize agriculture after 2013. The answer to the consequent cost increase of crop production may be the reduction of irrigated area and/or the production of new crops preferably of high value in the market and requiring less water for irrigation.

European Mediterranean countries started considering wastewater reuse for irrigation long ago. Although irrigation with wastewater is in itself an effective purification (a sort of low-rate land treatment), appropriate treatment must be performed for the protection of public health, the prevention of nuisances during storage and the prevention of damage to the crops and soils.

2.2.2. Urban water supply use profile

Urban water supply includes mainly households, public services, commerce and small industries. In average, the household consumption is around 45% of public water supply use in several countries (Hungary, The Netherlands and the UK).

2.2.2.1. Non-potable

The demand of urban water depends mainly on population served (population growth, population density) and socio-economic level of society. Large variations on public water use can be observed in Europe, caused not only by differences in lifestyle, but also by the water price and the leakage in the supply systems.

In addition to the wide variation in public water supply demand different trends can be distinguished: in some countries consumption has been decreasing (e. g. Denmark, Sweden, Germany) whereas other countries have shown an increasing pattern (e.g. Austria, Belgium, Italy, Switzerland). Use is highest in western southern countries largely reflecting the warmer climate in this part of Europe.

In the future, it is anticipated that in spite of population and socio-economic growth, urban water demand will stabilize or decline slightly, as a result of water pricing policies and improvement in efficient water usage.

2.2.2.2. Potable

Unplanned or incidental use of treated wastewater for drinking purposes has taken place for a long time. This occurs where wastewater is discharged from a wastewater treatment plant to a river and subsequently used as drinking water source for a downstream community.

Nevertheless, for the last twenty years, planned IPR has been studied. The use of environmental buffers such as rivers, dams, lakes or aquifers is considered world's best practice given that natural systems have a high capacity to further purify water. Retention time of the recycled water in the raw water supply allows some remaining contaminants to be degraded by physical processes (e.g. natural ultraviolet light) or biological processes (e.g. 'native' micro-organisms). Storage of the recycled water for a period of time before consumption provides an interval of time in which to either stop delivery of water or to apply corrective actions in the event of a treatment failure. Dilution of recycled water in the environmental buffer also minimizes any potential risk by decreasing the concentration of contaminants that may be present.

As for the planned use of treated wastewater for drinking purposes, recycled water Guidelines are now incorporating several approaches using a risk management framework to ensure minimum levels of risk and maximum quality of the final product water. Best Available Technology, Life Cycle Analysis and Hazard Analysis and Critical Control Points (HACCP) are some of the more commonly used approaches.

2.2.3. Industry use profile

Excluding cooling water, the main industrial water users are the chemical industry, the steel and metallurgy industries, the pulp and paper industry. Industrial use of water accounts for about 32% of total water abstractions in the EU. Cooling water represents about 10%, because most of cooling water is used and not consumed, generally returned to the water cycle.

The increase of water demand for industry is not expected in Europe in the future because of increased efficiency in industrial processes, greater water recycle and re-use as well as the decline of water intensive consuming industries in Europe.

2.3. ESTIMATION OF POTENTIAL WATER REUSE IN THE EUROPEAN UNION

The potential for reuse of treated wastewater in the regions is huge. Most countries are in different stages of developing official policies on the issue, some of them with specific plans for the next decades. Spain and Italy are expected to have the most conspicuous developments at short-term. The adoption of long-waited Regulations for urban re-use will boost the reuse of treated wastewater in this sector, thus, agriculture is not expected to be the almost sole consumer of treated effluents in the future.

However, wastewater reuse implementation is facing obstacles and delays mainly due to lack of clear policies defining treated wastewater as part of the water resources of the countries, legal and institutional frameworks for the implementations of reuse projects, proper training to farmers and information to public, and multi-nationals standards.

An estimation of potential water reuse in Europe has been made on a mathematical basis of the share of water demand and supply which can be covered by reclaimed wastewater. This approach was not based on cost considerations and incorporation of externalities but on a straightforward extension of the mass balance approach, although if it was premised on economic drivers, the equilibrium point, and thus, the variables of the equation applied, would be determined by price mechanisms. The aim of this study was to combine various general water management data and the currently verifiable status of wastewater reclamation and reuse in Europe as a basis to calculate reclamation and reuse-factors which describe the main influencing parameters on further development.

In the Figure below, it is depicted the wastewater reuse potential for most European countries according to the model calculation. On the whole, the estimate predicts a wastewater reuse volume of 3,222 Mm3/a. and on a European level, the reused wastewater volume would save 0,9% of the total water abstraction in the year 2025. While for most countries the substitution potential is less than 0.5%, Malta, Cyprus and Spain could cover up 26%, 7.6% and 3% of their future water demand respectively.

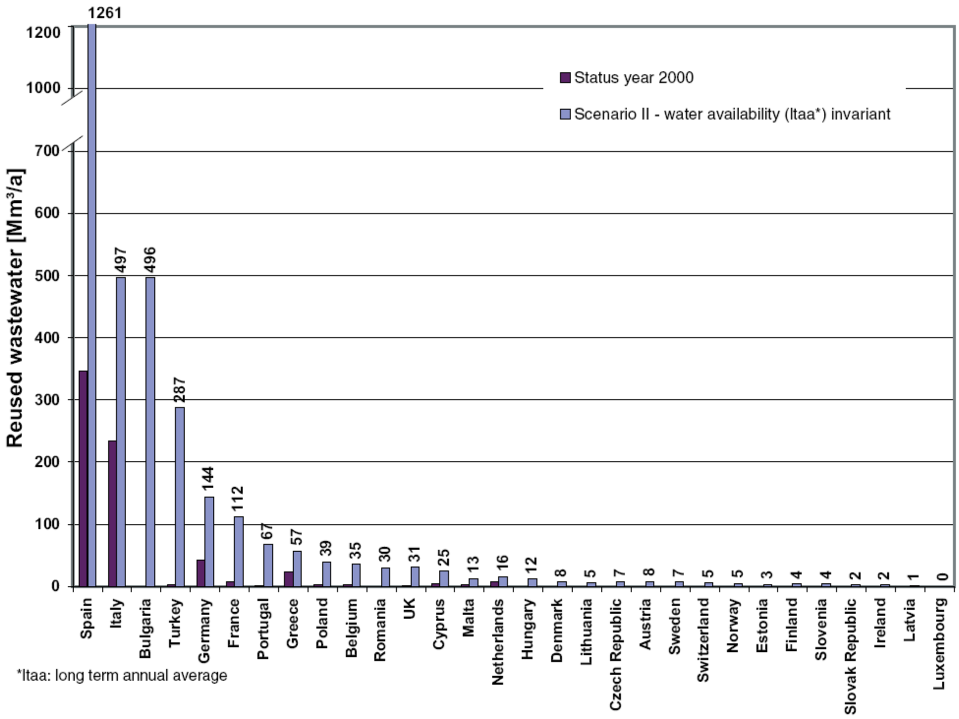

Figure 2. Model output for wastewater reuse potential of European countries on a projection horizon of 2025.

Evaluating the results with respect to the role of wastewater reuse in integrated water management, one has to consider that a quite moderate development of future water demand for most countries was projected. Furthermore, the available freshwater resources were assumed to be invariant in future years. Taking into account climate change impacts and water abstraction restrictions stipulated by national Governments (e.g. The Netherlands and Italy) in addition to the legislative duty to improve the wastewater treatment plant effluent quality, the wastewater reuse potential would further increase especially in countries whose reuse potential is insufficiently utilized due to little demand.

2.4. CURRENT WATER REUSE IN THE EUROPEAN UNION COUNTRIES

There are diverse water reuse realities amongst the countries of the European Union. Whilst in Southern Europe wastewater reuse is still a limited, but growing, source of irrigation water, in Northern Europe, it is barely practiced but could be developed for sanitation or environmental protection purposes in response to increasingly stringent environmental Regulations. Some detailed information is exposed below by countries considering the available data, the Regulations applied as well as the financing incentives in case there is any.

Highlight

No much data has been found concerning the quantitative value of reclaimed water for each Member State, therefore, all the data exposed in this section is expressed on a qualitative basis.

2.4.1. Austria

2.4.1.1. Water reuse current state of art

The water consumption for drinking water corresponds to about 0.06% of rainfall, and for both agriculture and industrial purposes to about 1.5%. Due to this favourable situation, water scarcity in Austria is only a limited local problem mainly in some eastern and southern parts. Mean drinking water consumption is about 159 l/inh, which is a moderate figure and has little changed during the last decade. About 98% of the drinking water derives from ground water and needs no or nearly no treatment. In Austria, the reuse of wastewater is only relevant where it contributes to reduce pollution and/or costs.

Preliminary studies indicate that in the Alpine basins the seasonal runoff pattern will change. Low-flow conditions occurring now in early winter will appear during fall because of increased temperatures. The melting period will also start earlier; the occurrence of monthly runoff maxima is basin dependent and will fall into the time period March to June. The number of days with snow cover will decrease as will the frequency and duration of frost periods. The increase in temperature and thus in evaporation is higher than the changes in rainfall and, therefore, there is a tendency towards a decreased runoff, which is only counterbalanced by higher runoff during winter.

2.4.1.2. Regulation applied and financing incentives

No Regulations or Guidelines exist in Austria. As water is a renewable resource, the basic goal of water protection in Austria is to make rational use of water and to minimize material flows to the receiving waters. Its reuse is only recommended if it results in overall economic and ecologic advantages. Therefore, for a number of industries, the specific water consumption is limited by law to a value which can only be reached by recycling water (e.g. pulp and paper industry, sugar industry).

Due to the Austria's Water Act, this country has a very strong precautionary principle for ground and surface water protection. Source control of water pollution has a high priority.

2.4.2. Belgium

2.4.2.1. Water reuse current state of art

Ten years ago, only 38% of all sewage was treated in Belgium. We know this number has currently increased to treat 70% of the sewage and is still going up. This fast wastewater treatment facilities growth has improved the prospects for possible reuse. However, this will largely depend on the relative costs of traditional sources of water and reused treated wastewater. Belgium is one of the member states presenting a high Water Stress Index. The reduction of effluent discharge in sensitive waters is an additional reason for reuse in Belgium. The Belgian Government wishes to reduce groundwater abstraction and stimulate water reuse.

Presently, almost all the urban wastewater is treated. There is a growing interest about recycle and reuse namely for industrial water supply (cooling water in power plants, food processing plants, textile industry), agriculture and groundwater recharge although the percentage of treated effluent that is currently reused remains very limited. Several episodes of unplanned indirect reuse have been detected as well.

2.4.2.2. Regulation applied and financing incentives

Back in 2003, the Flemish Regional Water Authority proposed the Government, based on Australian EPA Guidelines, a water reuse criteria, but no outcome has been registered to the day. So far, the incentives to reuse wastewater have been lacking in Belgium. Nevertheless, in some situations, the reuse of treated wastewater could become increasingly attractive in areas of dropping water tables or high summer water demand such as the coastal regions during the tourist season. The elimination of discharges in environmentally sensitive areas is also a reason for developing wastewater reuse projects.

2.4.3. Bulgaria

2.4.3.1. Water reuse current state of art

Even though being Bulgaria the second country with more water stress in the European Union, no specific data related to reuse of treated wastewater have been found. Possible final wastewater reuse systems have been usually considered in particular cases concerning the quantity, contents and the treatment technology of industrial wastewater. Such cases would involve the industries of Thermal Power Plants (cooling water), refrigeration installations (cooling water), food industry, paper industry and processing of non-metal mineral resources (kaolin, for example).

2.4.3.2. Regulation applied and financing incentives

Due to the water stress index, Bulgaria is currently contemplating Guidelines over the water reuse implementations. It needs to be said, that such Guidelines, still lack a lot of precision and accuracy.

Specifically, Bulgaria's Water Act Chapter 1, Article 2 (Amended, SG No. 65/2006), describes the aim of this water act as '*to ensure integrated water management in the interest of society and for protection of public health, as well as to create conditions to avoid water pollution by 'multiple-purpose and efficient use and reuse of water resources' amongst others*.'

Additionally, in Bulgaria's Water Act Section V Programs of Measures for Water Protection and Restoration, Article 156m (New, SG No. 65/2006), states that: '*each program shall include basic and, where necessary, supplementary measures. These supplementary measures shall be designed and implemented in addition to the basic measures with the aim of achieving the objectives under Section III of the same Water Act and may be: water efficiency and reuse measures in industry amongst others. (Amended, SG No. 61/2010)'.*

2.4.4. Cyprus

2.4.4.1. Water reuse current state of art

Cyprus is an island where tourism is a very important economic activity. Water scarcity and deterioration of bathing water on the beaches are growing as constriction factors to tourism development. The reuse of treated wastewater is an important contribution to the solution of both problems. Irrigation for several purposes (agriculture, landscape, green areas in hotel, golf courses) is the main application in Cyprus.

In Cyprus the annual precipitation is about 500 mm, 85% of which is estimated to be lost by evapotranspiration. Current total water use is 242 Mm3/yr, almost 80% used for irrigation. The wastewater generated by the main cities, about 25 Mm3/yr, is planned to be collected and used for irrigation after tertiary treatment. Because of the high transportation cost, it is anticipated that most of the treated wastewater, about 55 to 60%, will be used for amenity purposes used as hotel gardens, parks, golf courses, etc. A net of about 10 Mm3 is conservatively estimated to be available for agricultural irrigation. This will reportedly allow irrigated agriculture to be expanded by 8-10% while conserving an equivalent amount of water for other sectors.

The evolution of Cyprus water sources exploitation is shown below. Reclaimed water is an indispensable source for this country and it is to be expected that will still be in a future.

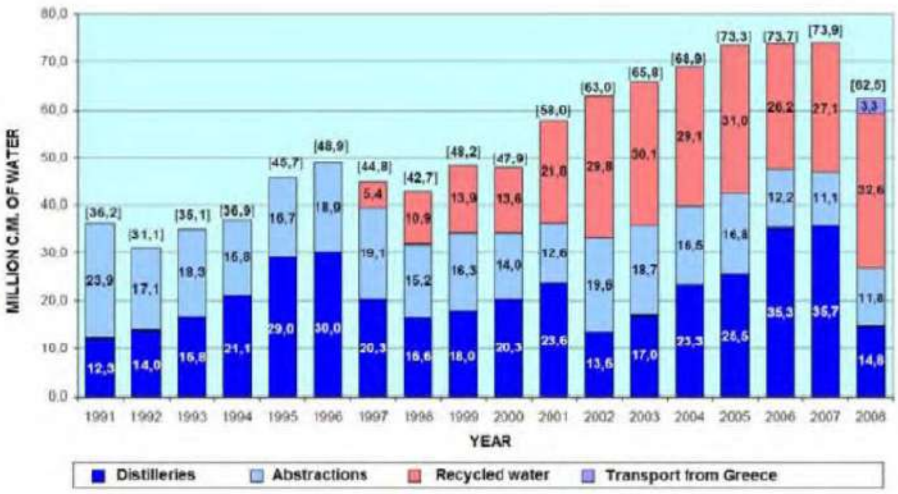

Figure3. Evolution of Cyprus water sources exploitation.

2.4.4.2. Regulation applied and financing incentives

Since 1990, there are provisional standards for treated wastewater reuse with quality criteria for irrigation. These standards are stricter than the WHO Guidelines and take the specific conditions of Cyprus into account. Since 2005, these standards went from provisional to definitive (Decree no 296/03.06.05). These criteria are followed by a code of practice to ensure the best possible application of the water for irrigation

2.4.5. Czech Republic

2.4.5.1. Water reuse current state of art

The Czech Republic is located at the watershed of three seas and most of the Czech watercourses flow into neighbouring countries. Priority issues for freshwater are water quality and pollution. Even though surface water quality has improved significantly since the 1990s, there is still a need to focus on the discharge of pollution and improve wastewater treatment.

Water quality is also affected by the increasing number and extremity of floods and droughts associated with climate change. Action is required here to help retain water in the landscape and support flood-protection measures. Given that droughts are increasingly frequent, the continuing decrease in water abstraction in the public sector and in industry is applauded. However, no specific data has been found about water reuse implementations.

2.4.5.2. Regulation applied and financing incentives

No Regulations or Guidelines have been implemented in the Czech Republic.

2.4.6. Denmark

2.4.6.1. Water reuse current state of art

The water supply almost entirely relies on groundwater resources. Thus, managing groundwater quality and quantity is of paramount importance for a sustainable water supply and use. As in other Scandinavian countries, the issue of wastewater reuse has so far never been considered seriously.

During the 1990s there were several initiatives financially supported by the Ministry of Environment to introduce in-house grey water recycling for domestic uses. But due to the inconsistency of political acting and several operational set-backs the practice was almost abandoned.

2.4.6.2. Regulation applied and financing incentives

Denmark WSI has been rated between 15 and 20 % and no Regulations or Guidelines have been done about the water reuse patterns implementation. High water prices encourage industries to recycle process and cooling water. One of the best known examples is the industrial symbiosis of Kalundborg where several companies mutually provide and recycle wastewater.

2.4.7. Estonia

2.4.7.1. Water reuse current state of art

A lot of attention is paid to sewage treatment. In several towns new wastewater treatment plants supplied with modern technology have been implemented in the last years. In 2003 the amount of sewage to be treated was 119 M m3/yr from which the rate of untreated sewage was less than 1%. Nevertheless, as Estonian WSI is around 10%, treated wastewater reuse has not been implemented.

2.4.7.2. Regulation applied and financing incentives

In Estonia, recycling of wastewater is not applied except for a limited amount in some industrial enterprises. In this case, thy reused water is named ‘recycling of conditionally clean wastewater’.

2.4.8. Finland

2.4.8.1. Water reuse current state of art

With a water availability value per capita higher than 20,000 m3/yr, Finland never needed to consider the reuse of treated wastewater for irrigation. The consumption of drinking water is 423 Mm3/yr and, over half of that, is groundwater. The industrial use of water is 1000 Mm3/yr and the use of cooling water is 5700 Mm3/yr. The need of irrigation in agriculture is quite low. The use of water for irrigation is less than 1% of the runoff and most of it is high quality surface water.

2.4.8.2. Regulation applied and financing incentives

No Regulations or Guidelines have been done.

2.4.9. France

2.4.9.1. Water reuse current state of art

French interest became focused on the wastewater reuse issue in the early 1990s because of the development of intensive irrigated farming, using very large quantities of fertilizers and water. The consumption of water for farming is growing strongly in South-Western France and the Paris region in particular, whereas consumption for industry seems to be falling, and domestic consumption has reached a ceiling that now even seems to be slowly declining.

In addition to the growing demand for water for agricultural purposes, some irrigated crops (such as corn) have become more widespread and periodical droughts have occurred. Over the last 20 years and more particularly there has been a long period of drought which has paradoxically affected the regions traditionally considered to be the wettest, in Western and North-Western France. In more than one-third of the country, water tables are falling as the autumn and winter rains are no longer making up for the amounts drawn up in spring and summer. Faced with this situation, the authorities have occasionally imposed restrictions on water use, a very unusual practice in France. It is also worth recalling that around fifteen French departments are situated in an area with a Mediterranean climate similar to that of Northern Spain and Italy, well-suited to market gardening, fruit farming and mass tourism. All of these tend to increase the need for water, at the time when resources are periodically insufficient. However, these departments do not experience serious water shortages because they were equipped with canals bringing water from the Durance and Rhone rivers.

Because of its good hydraulic infrastructure and sufficient rainfall around the country, France does not need to increase resources by relying heavily on wastewater reuse. So far, apart from the large Paris project, most applications of wastewater reuse have been limited to peripheral small communities and islands mainly because of the cost of tertiary treatment. Nevertheless, the projects implemented cover more than 3000 ha of land, and quite a wide variety of applications: market gardening crops, orchard fruit, cereals, tree plantations and forests, grasslands, gardens and golf courses. The recent development of new treatment processes to obtain very high-quality purified water, disinfected and with no suspended solids, could change the approach to the problem and could open the door to recycling for domestic purposes (cleaning, toilet flushing, etc.). The reuse of industrial wastewater after purification to supply cooling water, wash water or even process water after sophisticated complementary treatment is widely developed in France.

2.4.9.2. Regulation applied and financing incentives

Because of this new interest for wastewater reuse, the Health Authorities issued in 1991 the ‘‘Health Guidelines for reuse, after treatment, of wastewater for crop and green spaces irrigation’’ (CSHPF, 1991). These Guidelines indicate that a file must be prepared to get permission for wastewater reuse from the health authorities. This file must include a lot of information to enable the health authorities to estimate the environmental and health impact of the planned facility. They essentially follow the WHO Guidelines but add restrictions for irrigation techniques and set back distances between irrigation sites and residential areas and roadways. As a result, spray irrigation is strictly limited in urban areas. French Guidelines impose a stringent monitoring of the microbiological and chemical quality of reclaimed waters. A few other EU-countries are also oriented toward accepting the same Guidelines.

Following this publication, in February 1996, the Association of Water Supply and Sewerage Practitioners (AGHTM) published technical recommendations about the wastewater treatments necessary to ensure compliance with the French Guidelines. Furthermore, French Regulations make it compulsory for the departmental administration to apply for authorization for any wastewater reuse project. A review of these Guidelines is currently being considered.

Financial incentives have been available from the “Agences de Basin” (Catchment Authorities) for reuse projects in industry that demonstrate an environmental benefit. The most updated Regulations refer as water reuse for agricultural purposes and essentially follow the WHO standards. These are:

- Art. 24 Décret 94/469 3 1994: The wastewaters can, after purification, be used at agronomic or agricultural purposes, under control that water composition are compatible with the requirements of protection of the public health and the environment.

  The conditions of purification and irrigation procedures as well as the monitoring programs to be implemented, are defined, after approval of the Superior council of public health of France and of the interdepartmental mission of water, by a decree of the minister in charge for health, the minister in charge for the environment and the minister in charge for agriculture.

- Circulaire DGS/SD1.D./91/n°51 Sanity recommendations relating to the use, after purification, of urban waste water for the irrigation of crops and green spaces.

2.4.10. Germany

2.4.10.1. Water reuse current state of art

In Germany, the usable amount of water reaches 182 billionm3/yr. Only 25.8% of this is used: 15.8% by power stations 6% by industry, 3.1% by public water supply and 0.9% by agriculture. Therefore, there is little incentive for the recycling of wastewater. Nonetheless, direct wastewater reuse is practiced just in the agricultural sector. This is due to historical development where in regions with sandy soils agriculture has always only been feasible when irrigated. Formerly this was accomplished by untreated wastewater, but with the implementation of sewage treatment the method remained.

The wastewater treatment is operated in line with the requirements of the intended use: low nutrient degradations are achieved in summer during the vegetation period whereas during winter the sewage is denitrified and removed of phosphorus and use for groundwater replenishment.

In some regions (e.g. Ruhr valley and Rhine valley) the artificial recharge of groundwater is practiced. In these cases, surface water or river bank filtrate is used as raw water for drinking water production. Besides, the city of Berlin for 120 years has relied on the recycling of appropriately treated wastewater which is mixed with the surface water. This water is subject to bank filtration as it recharges the aquifers from which 100% of the potable water source is abstracted. Under dry weather conditions 70% of the available water has been recycled through the different water bodies.

2.4.10.2. Regulation applied and financing incentives

In some federal states (Landers), new Regulations about the seeping of collected storm water have been issued, but only when economic and ecological advantages could be achieved. The federal Water Act (Wasserhaushaltsgesetz) gives Germany a high level of protection for water, the best opportunity for the reuse of wastewater is through environmental protection schemes.

There is little incentive for the recycling of wastewater although, there are endeavours ongoing in the sector of grey water recycling and rainwater harvesting. Four regional areas in Germany provide subsidies for rainwater reuse and rainwater catchment is included in building Regulations with a fee for discharging rainwater into the sewer.

2.4.11. Greece

2.4.11.1. Water reuse current state of art

In Greece, water demand has increased tremendously over the past 50 years. Despite adequate precipitation, water imbalance is often experienced, due to temporal and regional variations of the precipitation, the increased water demand during the summer months and the difficulty of transporting water due to the mountainous terrain. In addition, in many south-eastern and island areas there is severe pressure for water demand. Therefore, the integration of treated wastewater into water resources management master plans is a very important issue.

Today, more than 65% of the Greek population is connected to over 350 centralised WWTP with a total capacity of over 1.45 Mm3/d. An analysis of data concerning the water balance of the areas of the treatment plants demonstrated that more than 83% of the treated effluents are produced in regions with a deficient water balance. Therefore, treated wastewater reuse in these areas would satisfy an existing water demand. Additionally, more than 88% of the effluents from wastewater treatment plants are discharged at less than 5 km from the available farmland. Therefore, the additional cost for irrigation with reclaimed wastewater would be low.

2.4.11.2. Regulation applied financing incentives

According to the JMD 145116/11 (GG B' 354/2011) the wastewater reuse shall apply on urban liquid waste and industrial wastewater as defined in the JMD 5673/400/1997 (GG B' 192/1997). The reuse may lead to production of drinking water, usually through mixing of the elaborated water with clean underground aqueous systems, and production of irrigating water allowed for agricultural use. Further the Joint Ministerial Decision determines the measures, procedures and processes for the reuse of treated wastewater.

2.4.12. Hungary

2.4.12.1. Water reuse current state of art

96% of Hungary's surface water comes from the neighbouring countries. Due to this fact, the quality and quantity of the Hungarian water bodies depend greatly on the interventions of these countries. However, Hungarian industrial and agricultural pollution contributes to the contamination of those as well and un- or not well-treated sewage plays a great role in the pollution load of the water supply. Since more than 90% of drinking water comes from groundwater, its protection is a strategic task in Hungary.

About the settlement structure of Hungary it can be stated that the proportion of settlements with less than 2000 inhabitants is high (75.3%) but only 16.9% of the population lives in there. Therefore the proportion of the amount of Hungary's whole wastewater flow coming from these settlements is only 4.7%. Despite of this fact, these are the places where the installation of small WWTUs should be taken into consideration regarding that their uniting into a wastewater treatment agglomeration is not feasible in many cases (mostly when these small settlements are far from each other in addition).

2.4.12.2. Regulation applied and financing incentives

In the case of Hungary, the numerous Regulations concerning on-site WWTSs and the legislation gap of water reuse hinder the spreading of environmentally feasible solutions for water reuse. One of the biggest problems connected to the introduction of small WWTUs in Hungary was that Regulation concerning their establishment, maintenance and the disposal of treated water was scattered in parts of more than ten laws, and the disposal of treated water was not regulated properly. Unfortunately the only way of disposal that could be permitted following the required examinations was the discharge of water into land drains according to Government Decree 50/2001. (3. IV.), despite of the fact that these WWTUs could produce high standard effluents assuming proper maintenance. This way, the treated water could be laid back to the house for non-potable reuse purposes.

It has to be stated that according to the former corresponding legislation (Government Decree 174/2003. 28. X.), only the disposal of treated wastewater originated from on-site WWTUs established in vulnerable areas is prohibited, treatment was not. Taking the costs of this solution into consideration if treated wastewater had to be delivered to a municipal WWTP, the implementation of a package plant became uneconomical. The only alternative in this case would be the total recycling and reuse.

Nowadays, there's still no legislation regarding water reuse. However, the Environmental Programme, under Decision 96/2009 (XII. 9) of the Parliament, and the River Basin Management Plan promote sustainable water use and water recycling through policy objectives in order to protect and preserve water quality and quantity. These programmes advocate the reuse of water locally through the use of treated wastewater for irrigation where lands are affected by water scarcity.

2.4.13. Ireland

2.4.13.1. Water reuse current state of art

About 75% of Irish drinking water is abstracted from surface water, the remainder supplied by wells and boreholes. Some 1000 public water supply schemes deliver in excess of 1.2Mm3 of water per day. Because of the mild and wet Irish climate, the need of irrigation in agriculture is practically non existent. Cooling water tends to be pumped directly from rivers or lakes. There is no evidence of any voluntary reuse of wastewater in Ireland.

2.4.13.2. Regulation applied and financing incentives

No Guidelines or Directives have been found.

2.4.14. Italy

2.4.14.1. Water reuse current state of art

A survey of Italian treatment plants estimated the total treated effluent flow at 2400Mm3/yr of usable water. This gives an estimate of the potential resource available for reuse. In view of the regulatory obligation to achieve a high level of treatment, the medium to large-sized plants (>100,000 inh. served), accounting for approximately 60% of urban wastewater flow can provide re-usable effluents for a favourable cost/benefit ratio.

Nowadays, treated wastewater is used mainly for agricultural irrigation covering over 4,000 ha. However, the controlled reuse of municipal wastewater in agriculture is not yet developed in most Italian regions and has decreased due to the low quality of water. Water reuse for industry is practiced in the metropolitan area of Turin. Municipal WWTP operator companies have already planned to build a separate supply network for wastewater reuse for industry (Azienda Po Sangone and CIDIU) in the Turin metropolitan area.

2.4.14.2. Regulation applied financing incentives

The use of wastewater for irrigation in Italy was regulated, since 1977 and till 2003, in the frame of the 1976 Water Protection Act (Annex 5, CITAI, 1977), being considered an extensive treatment process. The approach was in some respects quite stringent, no standards were set for toxic or bio-accumulative substances and a specific evaluation of the volume of wastewater which can be yearly applied, depending on soil and crops, was required. Other Guidelines dictated by the previous Italian legislation required warnings of possible hygienic dangers around the irrigated area (access had to be kept under control) and it had to be surrounded by a buffer strip of at least 80 m (without buildings or roads), regardless of the quality of the wastewater and of the irrigation system. Some other Regional Governments (e.g.: Puglia and Sicilia), using the powers given by the 1976 Water Protection Act, prepared and issued regional standards.

Following the frame of Law-decree n. 152, a new legislative set of rules was promulgated on June 12th, 2003 (Ministry Decree, D.M. no 185/03) applicable for agriculture, non-potable urban and industrial. A quite different and more complete approach was used regarding the water quality parameters and there was the possibility for the Regional Authorities to change some parameters and implement stricter norms. The proposed standards seemed to follow a quite restrictive approach, especially for some chemical compounds: in many cases the quality standards for reclaimed wastewater were the same as drinking water. This approach surely led to some difficulties in promoting wastewater reuse, when the compliance with some very strict standards asked for advanced treatments, with all the related consequences on the economics of the reclamation. Another negative aspect was the overabundance of parameters taken into account and their related monitoring protocols. In fact the number of parameters to be monitored exceeds 50 items and the sampling frequency can be very high, depending on the regional provisions.

It must be also considered that no regulatory distinction was established among various crops to be irrigated with reclaimed wastewater (restricted, unrestricted irrigation) and no attention was paid to the influence of different irrigation options (i.e.: subsurface drip irrigation, versus spray irrigation) in reducing sanitary risks. In summary: in a set of 54 control parameters - which is probably too large to assure an effective enforcement and monitoring - 20% of them ask for the same quality of drinking water; 37% of them are not even considered for drinking water, and the indication of some other parameters (for instance biocides and pesticides) was difficult to be explained in an agricultural environment.

Under these conditions, the total cost (construction, operation and maintenance) requested for reclamation, in addition to the costs for the distribution of reclaimed water and the monitoring of the whole reuse system, will be difficult to attain and will be probably tolerable only for large WWTPs, thus reducing the benefit of reclaiming water and hampering the development of wastewater reuse practices for the smaller ones; moreover, several successful reuse activities operating since a few years in small communities of Southern Italy inland areas, will certainly be obliged to face problems difficult to cope with. (Articles 11 and 12). Finally, Italian National Standards for reclaimed wastewater are exposed in Ministerial Decree nr 152 of May 2006, in order to regulate the use of wastewater.

2.4.15. Latvia

2.4.15.1. Water reuse current state of art

Freshwater quality improvement and protection against eutrophication are among the main priorities in Latvia's environmental policy. To ensure its rational use and long-term protection, water has been defined as a important national asset. However, water reuse is not a high priority for Latvia.

2.4.15.2. Regulation applied and financing incentives

Since 2000, a number of fundamental laws have been adopted to ensure sustainable development of the water ecosystem and relevant Cabinet of Ministers Regulations incorporating EU water legislation. The water management system has been reorganised and environmental protection measures are planned for river catchment basins. River basin management plans have also been developed and measures adopted.

Measures have also been introduced to reduce point source discharge pollution. In order to curb discharge of pollutants from waste water, the whole of Latvia has been designated as highly-sensitive territory for which special urban waste water treatment requirements apply. In addition, authorities have been set up to regulate pollutant discharge and use of water resources. Between 1995 and 2008, environmental protection projects totalling LVL 488.15 million were implemented. The largest proportion (LVL 385.55 million or around 79 %)

was invested in water services development to improve waste water treatment and collection and to provide good quality drinking water. Most of the financing (LVL 93.56 million) originated from EU funds (Phare, ISPA, the Cohesion Fund and the European Regional Development Fund) and from bilateral cooperation programmes. In recent years, investments to develop environmental protection for water services have increased considerably in Latvia.

As for water reuse, no Guidelines or Directives have been found.

2.4.16. Lithuania

2.4.16.1. Water reuse current state of art

By the end of 2004, the Lithuanian Water Suppliers' Association united 47 water utilities responsible for supplying and subsequent treatment of over 90 per cent of the gross volume of potable water in Lithuania. These water utilities have been treating approx. 98% of the wastewater disposed of in centralized systems, of which 90% is treated biologically. About 2/3 of the Lithuania's inhabitants make use of the services of centralized water supply and waste water treatment. As consumption of water shrinks, it is only a small percentage of the capacity of the treatment facilities, which is utilised.

Reuse of treated wastewater has not been developed yet. Most of the treated domestic effluent is discharged into surface water bodies. No instances of reuse of treated wastewater in industrial factories have been publicized so far. Believably, it is only a small share of such wastewater which could be reused in auxiliary technology processes.

2.4.16.2. Regulation applied and financing incentives

As for water reuse, no Guidelines or Directives have been found.

2.4.17. Luxembourg

2.4.17.1. Water reuse current state of art

National consumption of drinking water corresponds in average to 300 L/inh.d. Industry needs 25%, agriculture 30% and households 45%. Today, surface water covers about 1/3 of the average water consumption and up to 2/3 of the summer peaks.

As Luxembourg has no real problem in providing fresh drinking water, wastewater reuse does not rank high on the agenda of the country. Nevertheless, in order to protect its watercourses especially in summer, when the levels are low, some provisions have been made: industry generally is encouraged to recycle process and cooling water. The use of treated wastewater is being considered for humidification in the compost industry.

2.4.17.2. Regulation applied and financing incentives

As for water reuse, no Guidelines or Directives have been found.

2.4.18. Malta

2.4.18.1. Water reuse current state of art

The water deficit in Malta is acute. Since agriculture is the main source of income, wastewater reuse for irrigation has been contemplated as early as 1884 in order to preserve freshwater for domestic use. The recycled water is used to irrigate 600 ha of crops by furrow and spray irrigation. The water quality is suitable for unrestricted irrigation and is used to produce potatoes, tomatoes, broad and runner beans, green pepper, cabbages, cauliflower, lettuce, strawberries, clover, etc. Despite the high salinity, there are no problems with crops. This is probably associated with high permeability of the calcareous soil. Soil monitoring has shown a salt accumulation in the top soil during the irrigation season followed by leaching to the groundwater with the winter rains.

In 1986, the possibility of industrial wastewater reuse was considered. There are two large industrial water consumers on Malta: Enemalta, a thermal power plant and Malta Drydocks, a shipyard. Therefore, water of adequate quality for reuse in industry can be produced after extension of the Sant Antnin treatment plant. The use of the recycled water for industrial purposes depends primarily on the economic circumstances, namely on the comparison of the total costs of recycled water with other sources of water such as desalinated seawater. At the moment, recycled water is in use exclusively in industrial laundry.

2.4.18.2. Regulation applied and financing incentives

As for water reuse, no Guidelines or Directives have been found.

2.4.19. Netherlands

2.4.19.1. Water reuse current state of art

Some regions in the Netherlands (in the south-west, east and north-east of the country) can experience water shortages during dry spells. Reuse of water for irrigation is only possible when the quality of the water is sufficient: for crop irrigation, chlorine and iron are the limiting substances at present. The bacteriological quality of the water is mostly too poor to meet the standards for drinking water for cattle and for bathing waters. Reuse of wastewater can be a good option for certain industrial applications such as cooling systems, water for cleaning, etc.

So far, the total amount of wastewater recycling and reuse in the Netherlands is small. In few cases, recycled water is used for maintenance of the aquifer water level, water for fire-fighting and other urban uses. The use of recycled water depends on the local situation: availability of “good-quality” reclaimed water at a “competitive” distance, compared to surface water. In the near future, reuse will probably increase. The long-range perspective also foresees reuse as fire extinguishing water and industrial water. The infiltration and the use for irrigation are additional options.

In agriculture, wastewater will be stored and even treated to meet the standards required for this purpose. Water boards are also considering an additional treatment after tertiary treatment if the wastewater can be used for groundwater recharge in forest areas or other natural areas. For industries, the reuse of wastewater will be an option if it is cost-efficient.

2.4.19.2. Regulation applied and financing incentives

With the Dutch Government imposing taxes and limits on aquifer abstraction to reinstate original groundwater level, industrial wastewater reuse is becoming increasingly interesting. The installation of constructed wetlands as an option to realize environmental benefits by reusing wastewater was demonstrated for several locations in the Netherlands.

2.4.20. Poland

2.4.20.1. Water reuse current state of art

Water supply and sewage disposal conducted in Poland aims at both decrease of consumption of water resources and reduction of water environmental impact of sewage through reducing of the amount of sewage and pollutant load, eliminating environmentally dangerous substances from sewage, application of closed circuits and water reuse as well as wastewater treatment before its discharge into the environment. According to the Ministry of Environment report, presenting the implementation of the KPOSK, before the end of 2005, 323 investments were implemented and 63 of them were postponed for the next years.

2.4.20.2. Regulation applied and financing incentives

The Polish districts were obliged, by the power of The Local Government Act (March 8, 1990), to ensure disposal and treatment of municipal wastewater. Additionally, Water Act obliged the Minister of Environment to make and submit the National Program of Municipal Wastewater Treatment (KPOSK) to the Council of Ministers, which was adopted by the Council of Ministers as of 16.12.2003. The schedule describes the acts concerning equipping agglomerations with combined sewerage systems and sewage disposal plants, which will be undertaken till the end of 2015, and also for the intermediate periods 2005, 2010, 2013.

2.4.21. Portugal

2.4.21.1. Water reuse current state of art

In spite of the fact that Portugal is not bathed by the Mediterranean Sea, the Portuguese climate presents some features of Mediterranean climate particularly in the half of the country south of river Tagus. Under a natural regime 57.5% of the country mainland suffers a water deficit. Recurrent droughts severely affect the southern Portugal.

In Portugal, treated wastewater is a valuable potential resource for irrigation road construction and car washing. The volume of treated wastewater available today in Portugal exceeds 480 Mm3/yr. Even without storage, this amount could be enough to cover about 10% of the water needs for irrigation in a dry year. The use of treated wastewater for irrigation could significantly contribute to the agricultural development in the driest Portuguese provinces (Algarve, Beja, Evora, Setubal, Lisboa and Santarem). Roughly, between 35,000 and 100,000 ha, depending on storage capacity could be irrigated with treated wastewater.

2.4.21.2. Regulation applied and financing incentives

In 1998,the DL 236/87 National legislation relative to water quality standards for irrigation Annexes XVI and XVII defined the requirements water should have to be used for agriculture irrigation purposes concerning the metals, microbiology and salinity amongst other parameters.

Later on, in 2005, the NP 4434 National Standard Reuse of reclaimed urban wastewater for irrigation sets a National water quality standards and the related treatment schemes, the criteria for selecting the most appropriate irrigation process, equipment and practices and the associated monitoring programmes. It applies exclusively to treated urban wastewater use on irrigation of agricultural crops, forests, green houses and plant nurseries, lawns and other green areas. It specifically excludes industrial wastewater.

IN 2007, Rec.IRAR nr 2/2007 Use of treated wastewater: Guidelines of the National Regulator for water supply, wastewater and wastes services, (nowadays ERSAR, former IRAR) sets a Guideline for the production and distribution of treated wastewater for irrigation and talks about quality control , although it doesn’t specify the requirements. It also sets a base for calculating the water price and who should pay it.

In 2010, ERSAR Technical Guide nr 14: Wastewater reuse was approved, which consists in a technical guide of the National Regulator for water supply, wastewater and wastes services. It includes general uses of treated urban and industrial wastewater; agriculture and other irrigation uses, industry, aquifer recharge, recreational and environmental used and non potable urban uses.

2.4.22. Romania

2.4.22.1. Water reuse current state of art

Romania's water resources present a particular feature: 97.8 % of the rivers are collected by the Danube which flows for 1 075 km over Romanian territory or along the national border, out of its total length of 2 860 km. The long-term annual average (LTAA) available freshwater resource is 125 billion m3, of which 40 billion are in interior rivers and 85 billion are the Romanian share of the average annual flow of the Danube, plus an annual available groundwater resource estimated at9.6 billion m3. Consequently, usable water resources, including the Danube, amount to 2 660 m3 per person per year, which, compared to the European average of 4 000 m3/person/year, places Romania among the countries with relatively scarce usable water resources.

Concerning the volumes of wastewater collected, it has been established that (a) the total volumes of collected wastewater were of 4840.944 M m3, out of which 2910.658 M m3 (60%) wastewater that needed to be treated; and out of the volume of 2910.658 M m3 wastewater, 740.403 M. m3 (25%) were treated; 1290.421M m3 (44%) were insufficiently treated and 879.834 mil. m3 (30%) remained untreated.

Treated wastewater reuse has not been used since now due to the lack of effective sewerage systems and non-existence of secondary treatment plants.

2.4.22.2. Regulation applied and financing incentives

Water conservation, reuse and saving are encouraged by economic stimuli, mainly for those demonstrating a constant concern for protecting water quantity and quality, as well as by applying penalties for those who waste water or pollute the water sources. Penalties are applied to users who ignore provisions regarding excessive use of water, as well as those who discharge polluting substances into water sources.

As for water reuse, no Guidelines or Regulations have been found.

2.4.23. Slovakia

2.4.23.1. Water reuse current state of art

Treated wastewater reuse has not been used since now due to the lack of effective sewerage systems and non-existence of secondary treatment plants.

2.4.23.2. Regulation applied and financing incentives

No Guidelines or Regulations have been found.

2.4.24. Slovenia

2.4.24.1. Water reuse current state of art

In Slovenia development of the technology of treatment of various types of wastewater by constructed wetlands has recently started. One of the priorities of the constructed wetlands technology is water recycling and reuse. Unfortunately, so far the constructed wetlands are only used for small communities and consequently rather limited amounts of water to be recycled are generated. It is expected, that in the very near future, that technology, including water recycling and reuse, will be used widely and mainly in tourist areas.

2.4.24.2. Regulation applied and financing incentives

No Guidelines or Regulations have been found.

2.4.25. Spain

2.4.25.1. WATER REUSE CURRENT STATE OF ART

The reuse of treated wastewater is already a reality in several Spanish regions for four main applications: golf course irrigation, agricultural irrigation, groundwater recharge (in particular to stop saltwater intrusion in coastal aquifers) and river flow augmentation. Commercial interest exists and some private water companies invest in Research and Development activities, in collaboration with the Universities.. Multiple projects have been implemented treating brackish wastewater for irrigation and seawater desalination for irrigation in water short regions.

USE	Volume (hm^3/yr)	%
Irrigation	323.0	79.2
Urban uses	33.0	8.1
Golf courses and recreational uses	25.0	6.0
Industrial uses	3.0	0.7
Ecological uses	24.0	6.0
Total	**408.0**	100.0

Figure4. Use of treated wastewater in Spain in 2004

In the past, and in some places up to this day, wastewater was used raw for agricultural irrigation. Fortunately, the progressive implementation of the European Wastewater Directive is decreasing the availability of raw wastewater and increasing the volume of treated effluent to be disposed of.

Because of the lack of rain during several months every year, the flow of rivers on the Mediterranean coastline essentially consists of treated or untreated wastewater. Wastewater reclamation and reuse would therefore dry them up, prompting opposition from the ``environmental'' movements. However, the general opinion is that wastewater reuse all along the coastlines is a good solution and needs to be promoted. In spite of these hiccups, the future of wastewater reuse in Spain is promising. Unfortunately, its development is strongly correlated to drought episodes, touching Spain usually every 5 to 15 years and mobilising the public opinion.

2.4.25.2. REGULATION APPLIED AND FINANCING INCENTIVES

In Spain, the water re-use is being regulated by the Royal Decree 1620/2007, 7th of December, which establishes the legal regime for the reuse of treated wastewater. The main aim of this RD is to maintain a balance between the protection of health and the environment, providing a scarce and necessary resource as water, with a high level of quality.

The RD 1620/2007 defines the reuse of the wastewater as the application, before its return to the public hydraulic domain, for a new use once having received the necessary treatments as to accomplish the water quality parameter values set.

In order to reuse the treated waste water, it is necessary to possess reuse authorization and it will granted by the Basin Organization. The state Governments, regional or local, in order to encourage the reuse of the water and the efficient use of water resources carry out plans and programs for wastewater reuse.

On the other hand, on the touristy Mediterranean coastline, the development of wastewater reuse is especially promising for golf course irrigation. In spite of the lack of progress at national level for the moment, various initiatives have been taken at regional level. Andalusia, Catalonia and Balearic islands have issued comprehensive wastewater reuse Guidelines essentially following the WHO Guidelines and are encouraging the practice.

There is an initiative backed by the Ministry of the Environment, the CEDEX, AEAS (the EUREAU Spanish branch), ACA (Catalonia Water Agency), the Greater Barcelona Entity, several foundations (AGBAR, Canal de Isabel II and EMASESA) and the University of Barcelona to develop Good Reuse Practices and a Wastewater Reclamation and Reuse Risk Analysis, and since the end of 2004, there is an “ad hoc” Committee analyzing the old reuse draft never issued.

2.4.26. Sweden

2.4.26.1. WATER REUSE CURRENT STATE OF ART

In spite of its high availability of water resources and a low rate of abstraction of renewable water resources (just 2%), in the south eastern region of Sweden there is an interest for reusing the tertiary treated effluents of WWTP for irrigation. The reason for this practice reuse contributes to preserve coastal receiving waters and to conserve groundwater for nobler uses. There are over 40 reuse projects consisting of effluent storage up to 9 months in large reservoirs before being used for irrigation. In some cases the effluent is blended with surface water.

These schemes mean that wastewater treatment is handled in a cheap but very efficient way. Nutrients in the wastewater are recycled to farm land and the farmers are provided with cheap irrigation water. It is profitable for the Water Utility since it is selling water instead of constructing and operating expensive sewage treatment plants and for the farmers, since they secure and increase their harvests and they can also buy water cheaper than they had been able to do if they had constructed their own irrigation systems. This is also an ecological solution that avoids all discharges of more or less treated sewage water. This could also provide a more direct path to sustainable wastewater treatment than is normally the case in the western world.

2.4.26.2. Regulation applied and financing incentives

As for water reuse, no Guidelines or Directives have been found.

2.4.27. United Kingdom

2.4.27.1. Water reuse current state of art

The UK has used sewage effluents to maintain river flows (and ecosystems) and through river abstractions to contribute towards potable water and other supplies. This practice is particularly developed for the major rivers in the South and East where it is not always feasible to abstract upstream of sewage works.

There are some examples of direct treated wastewater reuse, mainly for irrigation purposes, golf courses, parks, road verges, car washing, cooling, fish farming, etc. Several schemes are being piloted to recycle wastewaters from washing machines, baths and showers, etc., for the flushing of toilets that accounts for a third of domestic wastewater reuse. In some of these, rainwater collected from the roof of the house in question is combined with the wastewater.

Several schemes have been piloted for grey water recycling (wastewater from washing machines, baths and showers) at Loughborough University for the flushing of toilets that accounts for a third of domestic wastewater reuse. In some of these, rainwater collected from the roof of the house in question is combined with the treated wastewater.

Overall, there is no consistent or extensive pattern of treated wastewater reuse in the UK. Normally, there has been sufficient water to meet demand so relatively few schemes for reuse have been developed. After the droughts of the last few years, these are expected to increase significantly with considerable public, political and climatic pressure in the UK to use water wisely, subject to appropriate assurances about quality and costs.

2.4.27.2. Regulation applied and financing incentives

The projects implemented have been complicated due to lack of clear Guideline on ownership of the wastewater, and of agreed quality issues. Information and guidance notes on the installation, modification and maintenance of reclaimed water systems and pipe work was published by the Water Regulations Advisory Scheme in August 1999. (WRAS).

The Government added water reuse with membranes in 2006 to the Enhanced Capital Allowances (ECA) scheme that provides financial incentive for industry to reuse wastewater through tax reductions under the previously applied for energy efficiency schemes.(Non fossil fuels etc). This ECA scheme is already operating for water saving devises and rainwater catchments. Water UK research group UKWIR with AWWA and Water Reuse Foundation published in 2005 a “ Framework for developing water reuse criteria with reference to drinking water supplies” as an aid to the decision making process and to identify the factors that need to be taken into account when planning and implementing a water reuse project.

3. RESEARCH PROJECTS ON WASTEWATER RE-USE

There have been more than 200 water reuse projects identified in Europe as well as many others in an advanced planning phase. The figure below shows the geographic distribution of the identifiable water reuse projects, including their size and intended use.

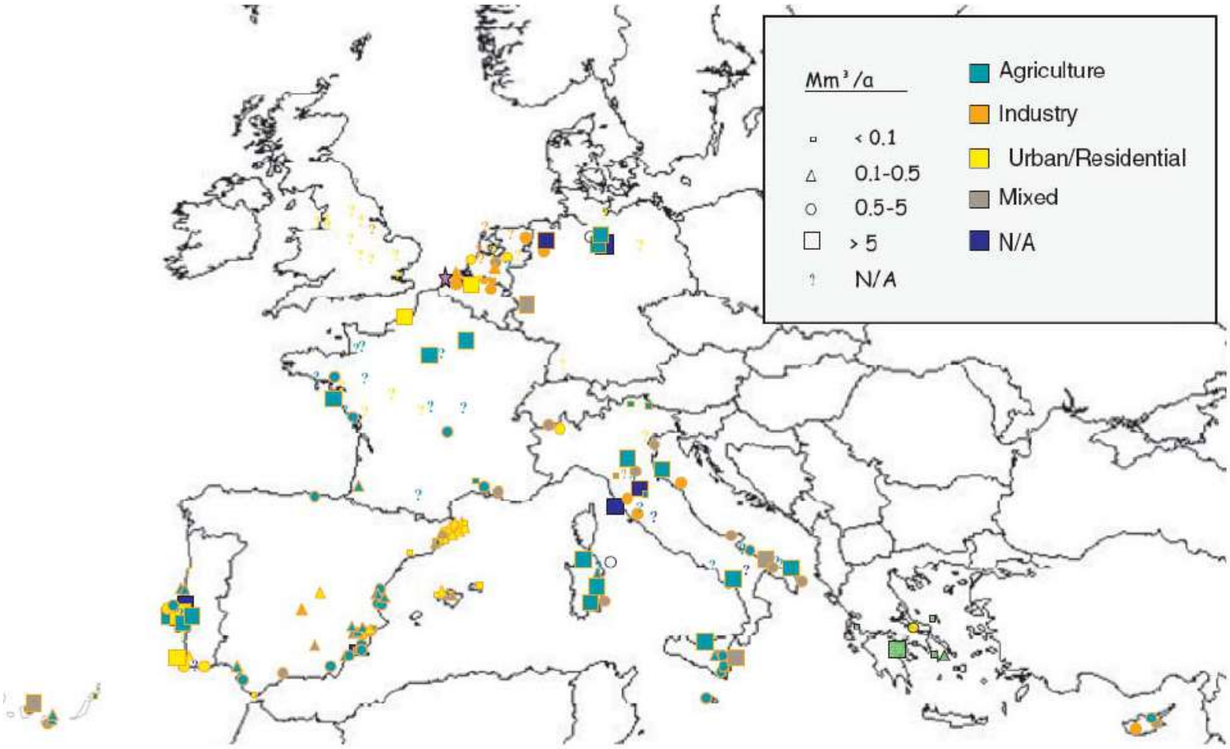

Figure 6, Exposing the water reuse projects in Europe. The areas of application are split into four categories: (1) agriculture; (2) industry; (3) urban, recreational and environmental uses, including aquifer recharge; and (4) combinations of the above (mixed uses). The scale of the projects is also split into four classes: very small (<0.1 GL/y), small (0.1– 0.5 GL/y), medium (0.5–5 GL/y) and large (>5 GL/y).

Much of the development has occurred in the coastline and islands of the semi-arid southern and in the highly urbanized areas of the wetter northern regions. The figure above shows that the use of reclaimed water is quite different between those two regions: in southern Europe, reclaimed wastewater is reused predominantly for agricultural irrigation (44% of the projects) and for urban or environmental applications (37% of the projects); in northern Europe, the uses are mainly for urban or environmental applications (51% of the projects) or industrial (33% of the projects).

3.1. SYNTESIS OF THE MOST IMPORTANT REUSE PROJECTS APPLIED ON AGRICULTURE

Option	Costs	Benefits	Most appropriate opportunities	Potential measures to increase uptake
Irrigation scheduling IRRINET (IT)	costs estimated to 55 000 EUR/year, and development costs around 300 000 EUR	Benefit to the farmer to identify economically beneficial agricultural systems Reduced water use	Everywhere	Awareness-raising and training about the tool Free access
Remote-sensing for irrigation, COLT project (IT)	unknown	Better assessment of water need by crops	Where remote sensing is available	Awareness-raising Subsidies for images
Winter storage reservoirs (UK)	Clay-lined reservoirs: €3.20/m^3 to 6,70 EUR/m^3 Reservoirs with a synthetic liner: 4,90 EUR/m^3 to 15,80 EUR/m^3, including energy (CO_2) from pumping twice (from borehole/river to reservoir; and from reservoir to field)	Overall benefit (to farmers) of moving to irrigation reservoirs can be estimated at around 30 EUR/m^3 as well as additional (non-monetised) benefits associated with improved security and flexibility of supply Reduced pressure on water bodies from reduction in summer abstractions	Areas with clay soils/clay available to line reservoir Where there is a need to deliver high quality produce (to meet contracts/ customer requirements) Where water is available for abstraction in winter Where water bodies are most stressed from over-abstraction in spring/ summer	Grants (to help farmers with some of the upfront and/or construction costs) Opportunities for co-operation between farmers to construct shared reservoirs and trade water between themselves

Response	Drivers for choosing the response	Main barriers	Water saved or volumes that were not abstracted
Water efficient irrigation systems (CY)	Increasing irrigation water efficiency Saving water	Capital costs (of new system) Appropriateness of the crops/soils (e.g. for drip irrigation) Training is required for farmers	Estimated to 75 million m^3 per year
Water allocation (CY)	Responding to competing water uses Reducing pressure on stressed water bodies and ecosystems	Acceptability of the hierarchy proposed Illegal abstractions	Rule The demand is met for: (1) 100% for drinking water uses, (2) 40% - 100% for greenhouses and permanent crops (3) 0-100% for seasonal crops (4) other uses
Water reuse (CY)	Reducing pressure on stressed water bodies and ecosystems	Sanitary issues Public acceptability Water treatment costs	About 10,5 million m^3 of tertiary treated water effluent is reused (not only for agriculture)
Regulatory limitations (FR)	Reducing pressure on stressed water bodies and ecosystems	Acceptability by farmers and other stakeholders Illegal abstractions	Threshold depends on the defined minimal river flow in the river basin
Change in cropping patterns (FR)	Limited water availability	Other economically viable solutions to grow other crops must be available	Depends on the crop chosen, may save no water, but use the same amount on smaller surfaces
Irrigation scheduling (FR)	Saving water	Cost (of measures, data, organisation) Requires a relative evenness in the crops grown in the region (since the scheduling is based on pilot fields)	High in wetter years, lower in scarce years
Water "turns" (FR)	Increase the length of time in which water is available	Cost (of organisation) Organisational issues (size of the river basin)	None – better spread over time of water abstraction
Irrigation scheduling IRRINET (IT)	Saving water	Training is required for the farmers Precision of the model Cost (of the model, data)	Estimated to almost 50 million m^3 (20% of the water used in agriculture)
Remote-sensing for irrigation, COLT project (IT)	Save water used in seasonal irrigation	Availability of remote sensing images Cost (of images, interpretation)	unknown
Winter storage reservoirs (UK)	Reducing pressure on stressed water bodies and ecosystems	Cost (site investigation, planning, construction, etc.) Planning restrictions Loss of land (on which to site reservoir)	Reservoir capacity considered was 40 000 m^3

Option	Costs	Benefits	Most appropriate opportunities	Potential measures to increase uptake
Water efficient irrigation systems (CY)	Training of farmers to use new techniques Government subsidies and long-term low interest loans	In 2009, overall water use efficiency of above 80%	Where water demand is high As first option to consider in the water hierarchy	Subsidies and loans Advice on appropriate systems
Water allocation (CY)	Organisation of the scheme Compliance checks	Reduced pressure on ecosystem Clear allocation rules for competing uses	Where competition for water is high Implemented best at river basin level	Regulatory means Collaborative organisation
Water reuse (CY)	Water treatment Water pumping (energy and CO_2) average cost 0,23 EUR/m^3 for tertiary treatment Salinisation of soils	Low prices for farmers (subsidised): 0,07 EUR/m^3 for agriculture and 0,15 EUR/m^3 for green areas etc. Security over water availability	Where wastewater discharge is an issue Treatment requirements depend on use (legumes, tree crops, golf courses, flowers, etc.)	Awareness-raising about the treated water Guidance and/or regulations to only allow low-risk uses Subsidies for treatment
Regulatory limitations (FR)	Compliance costs	Minimal water flow maintained	Everywhere	Regulatory means Collaborative organisation
Change in cropping patterns (FR)	Training/ knowledge of new practices	Possibly increased economic margins	Where alternative crops can be grown and sold Where climate and soils are appropriate	Organise alternative demand for crops
Irrigation scheduling (FR)	1,5 EFT for more than 3 months Costs of tensiometers (450 to 1 800 EUR, used for 6-10 years) 380 EUR per year for climatic data	Precise scheduling of irrigation timing and amounts Saved water	Everywhere	Organisation and funding by FAS
Water "turns" (FR)	One week full-time work (system with 20 farmers) More time and a computerised system may be needed for many farmers	Reduced pressure at a given time on the water body	Where collective organisation is possible	Organisation and funding by FAS

Case study	Water use	Main issues
Cyprus (one RB)	Water demand: about 250 million m^3/year Agricultural use: about 160 million m^3	Water stressed area Overabstraction (saline intrusions) Competition for water Difficulties to treat and discharge treated wastewater
Adour-garonne RB (France)	Water consumption for agriculture: between 650 million m^3 and 1 200 million m^3/year	Water shortages (regulatory limitations) Limited economically viable solutions for other crops Strong network of FAS
Po RB (Italy)	Total water abstractions: more than 21,7 billion m^3 per year Agriculture use: 17,7 billion m^3 (including livestock)	Relatively high availability of water currently, but adaptation to climate change required (in recent years dry periods occurred)
Anglian RB (UK)	160,7 million m^3/year licensed for irrigation around 55 million m^3 abstracted for spray irrigation	Water stressed area in the summer Availability of water in the winter

3.2. SYNTESIS OF THE MOST IMPORTANT REUSE PROJECTS APPLIED WITH OTHER APPLICATIONS

A project research has been though upon CORDIS database. The most important projects carried are show in the table below:

Advanced concentrate treatment for integrated membrane based water reuse systems
Drought and water scarcity are major global challenges increasingly having a significant impact on countries of the EU. The Commission estimated the economic impacts of drought events in the last 30 last years to be 100 billion at EU level.
Country: SWITZERLAND
Date: 2011-10-06
Water reuse in Mediterranean Countries
This project proposal is aimed to support and strengthen the different existing collaboration actions between Europe and Mediterranean Partner Countries (MCP) for research and research training in the field of Water reuse.
Country: ITALY
Date: 2012-08-01
Development of the next generation bioreactor system
Membrane bioreactor (MBR) technology is regarded as key element of advanced wastewater reclamation and reuse schemes and can considerably contribute to sustainable water management.
Country: GERMANY
Date: 2012-10-24
Regenerable active polyelectrolyte nanofiltration membranes for waterreuse and metal/acid recovery
The shortage of drinking water in many regions on the planet constitutes a real problem and hazard. The use of seawater, brackish water and wastewater for human consumption is not a new concept.
Country: GERMANY
Date: 2012-01-24
An innovative technology platform for the enhanced treatment of industrial wastewaters achieving cost reductions, electricity generation and enabling water reuse for non-potable applications.
Major water using and discharging industries are of significant European economic importance, generating >€1500 billion turnover and employing >7.5 million people in 220,000 companies (90% SMEs).
Country: UNITED KINGDOM
Date: 2012-02-29

RESOURCE EFFICIENT AND SAFE FOOD PRODUCTION AND PROCESSING
RESFOOD addresses on the most important topics in the food chain food towards resource efficient and safe food production and processing, leading to maximised resource productivity and recycling and re-use of valuable materials.
Country: NETHERLANDS
Date: 2012-11-22
Treatment of high organic load, high temperature and high salinity industrial waste water containing recalcitrant contaminants
PROMETHEUS aims to treat high organic load high temperature (85°C), and high salinity industrial waste waters containing recalcitrant contaminants originating from injection/extrusion and post-washing processes in aluminium and rubber parts production.
Country: SPAIN
Date: 2012-11-22
Safe and efficient treatment and reuse of wastewater in agricultural production schemes
TREAT&USE project aims to bring together 6 European SMEs and one RTD to prove and disseminate the technical and economic viability of a method for safe and economic wastewater treatment that allows a direct reuse of the water and nutrients in agriculture.
Country: SPAIN
Date: 2012-07-19
A Novel and combined domestic grey water treatment and heat recovery system suitable for cost effective installation in 90% of European households
AquaConserver concept addresses the twin problems of energy and water conservation faced by all citizens of the EU27 and offer us, as Europe's leading SME Plumber, equipment suppliers and consulting Associations.
Country: UNITED KINGDOM
Date: 2011-11-07
Photocatalytic and membrane technology process for olive oil mill wastewater treatment
Presently available methods for the treatment of olive mill waste water are not acceptable from the environmental point of view (evaporation, discharge) or not suitable from the economic aspect (membrane treatments) costing 10-20% of revenues from oil.
Country: ITALY
Date: 2013-04-18
Development of cost effective reliable robust flexible compact and efficient degassing and aeration method for intensive aquaculture
Land based fish farming is the critical success factor in intensive aquaculture since land based fish farms are the start of a very complicated value chain representing a prerequisite in order to have competitive sea farms.
Country: NORWAY
Date: 2010-10-18

Biotechnological recycle of olive mills washing water by microalgae
The EU is the most important producer of olives in the world, from 2001-2007, 2,2 million tonnes of olive oil were produced in about 12.000 olive mills, which accounts for the 80% of the world production.
Country: SPAIN
Date: 2011-11-15
Reduction of environmental risks, posed by emerging contaminants, through advanced treatment of municipal and industrial wastes
In the Western Balkans, a decade of regional conflicts combined with insufficient institutional infrastructure, decaying industrial system and a legacy of years of unchecked pollution have left the environment of the region in a state of serious neglect.
Country: SPAIN
Date: 2007-06-11
Synthesis of new Schiff base derived catalysts: Application towards enantioselective reactions in greener and more sustainable media
Over the past few years, the need for greener processes in chemical industries has considerably grown up. The aim is to solve the issue of organic solvents, non-pollutants media such as water , fluorinated solvents and supercritical fluids (SCFs).
Country: FRANCE
Date: 2013-04-18
Improvement and innovation of aquaculture effluent treatment Technology (AQUAETREAT)
The project examines the feasibility of cost-effective systems for the treatment and valorisation of aquaculture farm effluent, and the re-use of products and by-products of such systems, providing a solid base for reducing the environmental impact.
Country: FRANCE
Date: 2010-12-17
Preventing pollution and saving water resources by reuse of industrial rainwater
Realization of a storm water reuse system on a demonstration site of the car industry. Demonstration of the liability and stability of its performance for the reuse of treatedwater in industrial processes.
Country: FRANCE
Date: 1998-01-14
Efficient membrane filtration units with integrated High Frequency Backpulsing device
Membrane filtration has become a key technology for many environmental and industrial applications. Yet in spite of several cleaning options at hand, fouling phenomena such as cake layer formation and pore blocking still limit its performance.
Country: GERMANY
Date: 2011-09-20

Addressing global sustainability challenges by changing perceptions in catalyst design
One of the greatest challenges facing society is the sustainability of resources. At present, a step change in the sustainable use of resources is needed and catalysis lies at the heart of the solution.
Country: UNITED KINGDOM
Date: 2012-07-06
Demonstration of an environmentally friendly integrated waste watereffluents disposal and reuse systems
The aim of the project is to reuse the treated wastewater effluent, discharged from municipal waste water plant, in irrigation applications. The results foreseen are: - environmentally acceptable reuse of wastewater effluents - extended forestation.
Country: GREECE
Date: 1998-01-05
Partnerships for sustainable shrimp aquaculture
Aquaculture effluents represent a main environmental concern because of their high polluting potential. While fish farms of advanced countries adopt a medium/high-tech approach to this issue, less industrialised countries rely on low-tech systems.
Country: ITALY
Date: 2012-10-04
Innovative processes and practices for wastewater treatment and re-use in the Mediterranean region
The need to introduce remediation and treatment technologies in the water cycle was recognized by the European Commission under the 5th and 6th Framework Program and several research projects aiming at improving WW treatment techniques.
Country: SPAIN
Date: 2010-11-24
Mediteranean development of innovative technologies for integrated water management
MEDITATE aims at the development of a water management support system at the Mediterranean catchment level, integrating the use of alternative water resources such as karst submarine springs, seawater or brackish water desalination and water reuse.
Country: FRANCE
Date: 2009-12-07
Development of Advanced Wastewater Treatment with Ozone Oxidation and Flotation Technique for Maximum Water Reuse
The EU countries are still far away from the goal of reducing hazardous substances polluting European waters . Today, the Union's problem in this regard is worsening considering the state of water quality in the new member countries.
Country: NORWAY
Date: 2008-11-13

Supporting the implementation of FP6 research activities related to wastewater use and recycling by using new generation greenhouse systems, adapted to the requirements of the MED partner countries
Mediterranean Countries struggle with serious water problems like rising watercompetition between agriculture, households and industry, but limited and/or salt-affected water resources, irregular rainfall, escalating dehydration of landscape.
Country: GERMANY
Date: 2010-01-15
Sustainable waste water recycling technologies for irrigated land in nis and southern European states
In irrigated areas in the NIS and Southern European States, inefficient use of conventional water resources occurs through incomplete wetting of soils, which causes accelerated runoff and preferential flow.
Country: NETHERLANDS
Date: 2010-07-05
Impacts of contaminants in EU inland, coastal and drinking waters
Country: ITALY
Date: 2003-10-22
Support program for strengthening the capacity building of wastewater reclamation professionals in the context of the med-reunet network
Med-Reunet II continues the main objective of the Med-Reunet project (ICA3-CT-2002 -50002) of consolidating a highly experienced working group in the Mediterranean basin in order to enhance co-operation between European and Mediterranean authorities.
Country: SPAIN
Date: 2009-04-03
Re-use of potable water sludge replacing iron salts in waste water treatment and industrial applications
The project is to demonstrate the feasibility of the full-scale re-use system for potable water sludge, hereby including: - a detailed insight into the operation and design of the sludge acidification process.
Country: NETHERLANDS
Date: 1998-01-14
Integrated water management of Mediterranean phosphate mining and local agricultural systems
The phosphate industry is a major contributor to the economy of some Medit. countries (Morocco, Jordan, Tunisia, etc). Large volumes of water are required by the mining industry from areas where water resources are scarce or limited.
Country: FRANCE
Date: 2009-04-01

New Energy Efficient approach to the operation of Membrane Bioreactors for Decentralized Wastewater Treatment
The Mediterranean basin is one of the poorest regions in the world in terms of wateresources. An increased water consumption rate for irrigation purposes along with a high urban population growth, have had an adverse effect on water resources.
Country: GERMANY
Date: 2008-10-01
Traditional water techniques: cultural heritage for a sustainable future
Ancient practices of water harvesting, catchment and distribution had guaranteed for years water supplying to the countries and the towns all over the Mediterranean area.
Country: BELGIUM
Date: 2010-01-21
Development of an intelligent fish tank for cost effective aquaculture through control of water quality in each different fish tank.
European aquaculture production has increased substantially over the last decades. However, overall production growth in Europe over the period 1994-2003 was 5.5% less than the global trend over the same period.
Country: NORWAY
Date: 2008-11-13
Interference Management Techniques for MultiCell Wireless Networks
Future wireless communication systems should provide a wide range of services at a reasonable cost and sufficient quality of services (QoS), comparable to wire line technologies.
Country: FRANCE
Date: 2013-04-18
Promotion and focusing of current research activities of Membrane Technology in Water Treatment in the Mediterranean Region
The complex dimensions of the Mediterranean freshwater resources, their fragility and their scarcity have been highlighted and have received considerable attention as a primary priority issue politically, technically and scientifically.
Country: GERMANY
Date: 2007-07-02
Data e-Infrastructure Initiative for Fisheries Management and Conservation of Marine Living Resources
Marine life plays a vital role in the Earths ecosystem. Wise and judicious management of all relevant resources is of paramount importance to ensure that all forms of marine life remain sustainable.
Country: FRANCE
Date: 2013-01-09

Application of membrane technology to recover process waters for re- use by recycling within the food and beverage industry, environmental management improvements
Country: AUSTRIA
Date: 1998-01-14
Innovative Wastewater Treatment Applications for Isolated Locations (IWAPIL)
Due to the likely toughening of environmental legislation in the near future, many of the currently operating wastewater treatment systems will no longer be acceptable, and will have to significantly increase their efficiency.
Country: GERMANY
Date: 2013-03-08
Sustainable water supply limiting ground water use by re-use of local surplus water as domestic water for non-drinking purposes through dual piped supply
The project is expected to result in a sustainable water cycle system which: - reduces the potable water consumption from 105 to 50 liters per day per person, and therefore - substantially reduces the quantity of groundwater.
Country: NETHERLANDS
Date: 1998-01-14
Industrial wastewater treatment with reuse of treated water
Membrane BioReactor installation and usage of clean technologies are result of reflexion about global water gestion. This will allow to: - respect the environment by limiting the pollution discharged (SS, COD, TKN) and while complying with the new regl...
Country: FRANCE
Date: 1998-01-14
Application of electro dialysis with bipolar membranes for the re-use of acids and bases used in the regeneration of ion exchangers
Avoidance of salinity in waste water by the recovery of the acids and bases applied in the regeneration of ion exchangers.
Country: GERMANY
Date: 1998-01-05
Development of electro-coagulation technique for optimal cleaning efficiency and maximum reuse of water in land based fish farming
European aquaculture production has increased substantially over the last decades. However, overall production growth in Europe over the period 1994-2001 was 6.3% APR, 5.5% less than the global trend over the same period.
Country: NORWAY
Date: 2008-11-13

Reduction, modification and valorization of sludge
The adoption of the Urban Waste Water Treatment Directive 91/271/EEC imposes the sewage sludge to be subsequently treated so it is expected by 2005 to increase twofold in comparison whit 1992.
Country: SPAIN
Date: 2009-07-23
Improvement and innovation of aquaculture effluent treatment Technology (AQUAETREAT)
The project examines the feasibility of cost-effective systems for the treatment and valorization of aquaculture farm effluent, and the re-use of products and by-products of such systems.
Country: FRANCE
Date: 2013-03-08
Hammam, aspects and multidisciplinary methods of analysis for the Mediterranean region
Scenarios for the adaptive reuse of the Hammarn as a public service center for Mediterranean cities is the topic of the study HAMMAM.
Country: AUSTRIA
Date: 2010-01-22
Demonstration plant and spin-off projects for the recovery of backwash water treatment using dead-end membrane filtration
Country: NETHERLANDS
Date: 1998-01-14
Purification of water by zeolitic substrates with complete recycling of all components: application in the fertilizer production
Purifying a waste stream that contains ammonium nitrate (AN) with complete reuse of the water , the purifier and the removed substance. The used zeolitic substrate enriched with AN serves as raw material for complex fertilizers.
Country: BELGIUM
Date: 1994-12-07
Interaction between biology and membranes in membrane bioreactors
Country: BELGIUM
Date: 2010-01-12
Testing and commercial development of pulsed plasma shockwave technology for treating waste water , sewage and liquid industrial and agricultural wastes
The project aims to demonstrate that pulsed plasma shockwave technology can provide a revolutionary, clean and low cost method for purifying polluted waste water for reuse.
Country: UNITED KINGDOM
Date: 1994-12-07

Prevention and detection of fouling on ship hulls
Biofouling is the adhesion of biological materials to hard surfaces, such as ship hulls, in a marine environment and it can commence within seconds of the immersion of a ships hull in the sea.
Country: UNITED KINGDOM
Date: 2013-04-10
Prevention and detection of fouling on ship hulls
Biofouling is the adhesion of biological materials to hard surfaces, such as ship hulls, in a marine environment and it can commence within seconds of the immersion of a ships hull in the sea.
Country: UNITED KINGDOM
Date: 2013-02-13
Washing method for linen at a cold temperature using ozone and treatment of drain water
The demonstrated process is a washing method for linen at cold temperature using ozone and equipped with a treatment of wastewater.
Country: FRANCE
Date: 1998-01-14
Iraklion waste water reclamation pilot study for irrigation and groundwater recharge
The main aims of the project will be: a) To evaluate the wastewater tertiary treatment efficiency; b) To evaluate the effect and the safety of irrigation with reclaimed water and to develop design criteria for full scale projects; amongst others.
Country: GREECE
Date: 1994-12-07
Demonstration of microalgae cultivation as a new agro-industrial activity linked with urban wastewater reuse and CO2 biofiltration from combustion gases
The main objective of the presented application is to demonstrate, as a pilot scale (1 000m{2}), the efficacy and profitability of a new ecological agro-industrial system, a microalgal cultivation unit.
Country: SPAIN
Date: 1998-01-14
Integrated resource optimisation in the dairy processing industry
The aims of the project are to install a system to (a) recover water for plant reuse (b) reduce effluent (c) recover energy (d) reduce chemicals. The savings resulting will permit the system to be operated on a commercially viable basis.
Country: IRELAND
Date: 1994-12-07

Environmental pilot programme to encourage the sustainable economic development of Jerte's Valley Municipalities Association
The aim of the project is to demonstrate the compatibility of economic and industrial development and the preservation of the Natural Environment.
Country: SPAIN
Date: 1998-01-14
Demonstrative implementation on an innovative system of rational use and re-use of water in a residential building in Bologna
Country: ITALY
Date: 1998-01-14
Re-use of urban storm waters: treatment by aero flotation, filtration and disinfection before discharge into water sport environments
Country: FRANCE
Date: 1994-12-07
Sustainability of Tourism and Agriculture through Total consumer involvement
LandState creates an integrated system, in which a farm sustainably produces a diversified set of food products, placed in urban consumers, through a personalized home services company, and provides rural tourism to the same set of consumers.
Country: PORTUGAL
Date: 1998-01-14
Marine Microorganisms: Cultivation Methods for Improving their Biotechnological Applications
Marine microorganisms form an almost untapped resource of biotechnological potential. However, its use is hindered by the low success rate of isolation of novel microorganisms and often by poor growth efficiency.
Country: NETHERLANDS
Date: 2012-08-10
Ecological Reuse of Agro industrial sub products of Hellin Area
The aim of the project is to demonstrate that the application of innovative technologies in the reuse of agroindustrial byproducts of the Hellín area is a powerful and practical tool to manage a sustainable development of the region.
Country: SPAIN
Date: 1998-01-14

4. IDENTIFICATION OF THE MAIN DATA GAPS ON WASTEWATER RE-USE

4.1. AVAILABILITY OF DATA

During the edition of this Study, several databases have been looked upon (Eureau, Eurostat and EAA) but no quantitative data associated to EU countries water reuse amounts have been found, leaving a gap for statistics and visual documentations section in this document. Thus, all the data exposed has been taken from papers and documents published by scientific and Governmental entities, whose reliability has been demonstrated and consolidated for several years.

It needs to be said, though, that, besides data related to the water reuse in the European Countries, other data related to imbalances (precipitation, evaporation, water inflows / outflows) have been searched in these databases, whose the last update was in 2009. Therefore, it is highly recommended a rigorous data implementation into the EU databases, in order to take decisions and head action leaning on firm foundations.

4.2. RELIABILITY OF FALKENMARK WATER STRESS INDEX

The reliability of the WSI is a worldwide used indicator for water management. However, the use of national annual averages tends to obscure important scarcity information at smaller scales needs to be mentioned. Simple thresholds omit important variations in demand among countries due to culture, lifestyle, climate, etc. Finally, this index appears to under-measure the impact of smaller populations, by failing to measure water stress at these scales.

Furthermore, it does not take the water quality into account at all nor does it give information about a country's ability to use the resources. As to say, even if a country has sufficient water according to the Falkenmark indicator, these water resources possibly cannot be used because of pollution or insufficient access to them.

4.3. RECYCLED WATER QUALITY: MONITORING AND RISK ASSESSMENT

Analytical methods have been developed for a wide variety of compounds and isotopically labelled standards have become commercially available in recent years. However, more research is needed not only to identify new potential contaminants of concern in recycled water, but also to develop validated methods and implement harmonized analytical methods. Validated methods for emerging and other unregulated contaminants will facilitate the risk assessment and regulatory process by providing better quality data and provide comparative information about contaminant fate and removal during the treatment barriers as well as assist the analysis of different treatment options for removing contaminants.

The Norman Project, funded in 2005, has created a network of reference laboratories and related organizations for chemical monitoring and biomonitoring of emerging environmental pollutants and has launched the EMPOMAP database, in order to validate and standardize the chemical analysis and biomonitoring techniques for recycled water relating to emerging pollutants.

Furthermore, a greater research focus to manage health risks from trace organic compounds in recycled water is needed, with a particular emphasis on investigating the toxicological relevance of endocrine disrupters and pharmaceuticals in recycled water. The impact of endocrine disrupters in fish and other species exposed to wastewater have already been documented, but the implications of these findings for human health remain inconclusive

4.4. REGULATORY FRAMEWORK

All the regulatory framework concerning water reuse are exposed in the previous report '*Water reuse in the European Union', section 4*.

The current EU Framework Directive does not specifically mention the desirability of wastewater reuse, but it introduces a quantitative dimension to water management, on top of the usual qualitative dimension, which may stimulate the consideration of wastewater reuse. It also states that ''*water resources should be of sufficient quality and quantity to meet other economic requirements''*.

So far, a variety of approaches has been taken by different agencies to regulate water quality for wastewater reuse systems across Member States of the European Union. These differences pertain mostly to the existing irrigation practices, local soil conditions, the desire to protect public health, the choices of irrigation and wastewater treatment technologies and the need to keep costs down. Existing wastewater reuse Guidelines typically cover four areas for each application: physicochemical standards, microbiological standards, wastewater treatment processes and irrigation techniques. The degree of treatment required and the extent of monitoring necessary depend on the specific use (e.g. landscape irrigation or crop irrigation) and crop (e.g. eaten cooked or raw). In general, irrigation systems are categorized according to the potential degree of human exposure (e.g. long-range exposure through spray irrigation and short exposure through drip irrigation). The highest degree of treatment is always required for irrigation of crops that are consumed uncooked (the so-called ''unrestricted'' irrigation). Health risks associated with both pathogenic microorganisms and physico-chemical constituents, including persistent organic.

However, outside of Europe, most countries, such as Israel (a notable Mediterranean exception), South Africa, Japan and Australia, shy away from accepting the 1989 WHO Guidelines (WHO, 1989), considered too lenient for public health protection in industrialized countries. Around the Mediterranean however, and particularly in Europe, while the competent authorities recognize the limitations of the WHO Guidelines, most existing Regulations and Guidelines follow them but contain additional criteria such as treatment requirements or use limitations in order to ensure proper public health protection. In a number of other countries (Cyprus, Italy, Spain, Portugal, Greece and France,) Regulations concerning the use of recycled wastewater for irrigation are under discussion, preparation and/or revision.

5. IDENTIFICATION OF THE REMAINING TASKS NECESSARY FOR THE PREPARATION OF AN IMPACT ASSESSMENT

Despite the fact that water reuse is already becoming an essential and reliable water supply option for many municipalities, there is still significant potential for an increased utilisation of reclaimed wastewater. There are though a number of common issues that will have to be tackled if the water reuse potential is to be tapped to the fullest. Some of these issues are described in the following paragraphs.

5.1. SOCIAL IMPACTS

5.1.1. Public acceptance

It is important to note that the perception revealed by the European survey is that, in the view of some public administrations and of the population, treated wastewater still remains basically wastewater. It is widely known that in many urban and semi-urban areas in Europe surface or ground waters can have bacterial and chemical quality worse than that of a secondary-treated wastewater.

In many existing urbanized catchments the water cycles actually include indirect, unplanned and uncontrolled reuse of wastewater. The acceptance of water recycling is a social factor with a high emotive content. In some cases the involvement of local NGOs and environmental associations was a critical success factor, as the Ampuriabrava project in Spain, clearly demonstrated. Their involvement in building up credibility, trust and confidence is often underestimated.

Effective communication between the community, key stakeholders and the project proponent is crucial to achieve community support. All recycled water projects need to be accompanied by community education to demonstrate that the current technology is adequate to protect human health. A timely and active communication program to discuss the treatment processes, the risks, the measures in place to control risks and the safety of the water, may help to increase trust in the project.

Although communities have accepted recycled water for non-drinking purposes such as irrigation of parks, they are less likely to accept the use of recycled water as a drinking water source. The perceived decrease in temporal and geographical distance between wastewater and recycled water in Indirect Potable Reuse raises reservations amongst the community about the safety and quality of the recycled water. Nevertheless, increased community support has occurred in the last decade and important progress has occurred in identifying factors of success or failure in the implementation of IPR projects. Five aspects were identified by the Water Environment Foundation for building and maintaining community support in recycling projects: managing information for all stakeholders; maintaining individual motivation and demonstrating organizational commitment; promoting communication and public dialogue; ensuring a fair and sound decision-making process and outcome and building and maintaining trust.

Community attitudes to water recycling are dependent on numerous factors, including the degree of water scarcity, the supply costs, the quality of the consultative processes, the perceived management of health risks, and the accountability of, and trust in, the regulator, the Government and the water utility. Therefore targeted social research is needed in communities where Indirect Potable Reuse is proposed to understand the influence of psychological factors related to perception of risk, motivations, attitudes, beliefs and behaviour on the use of recycled water to supplement existing water supplies and IPR project acceptance.

5.1.2. Water management

The need for a best management practice framework is well acknowledged within the EU according to a survey undertaken by the EUREAU Water Reuse Group. Plenty of information on water reclamation and reuse practices is already available but is often fragmented and open to misinterpretation. Of particular importance are the management practices to reduce and communicate the risk of human exposure. Management practices of quality control and failure management vary considerably from region to region and even from project to project. A common trait in process operation and risk management of the surveyed projects is the adoption of extensive quality control practices and, in particular, the widespread use of instrumentation, control and automation. On the other hand, despite the fact that procedures such as Hazard Analysis and Critical Control Points are increasingly used to direct efforts in process control and monitoring to guarantee hygienically safe reclaimed water, very few surveyed projects have used them. Another interesting point is that very few projects seem concerned about emerging issues such as trace organic contamination.

Most of the member states have yet to adopt national legislation to comply with the Water Framework Directive even though the WFD is considered to be a soft legal document, as it sets forth the principles to achieve sustainable water governance, but not the means. In developing the appropriate means at local level there is a need to go wider in thinking and to gain a good balance between disciplinary expertise and interdisciplinary understanding. The challenge for the water reuse specialists here is to educate and re-orient their own institutions to more conscious and sustainable practices by bridging the tight but artificial compartments of water supply and sanitation.

The tight compartmentalization of water supply and sanitation is a factor that produces a considerable time lag between the feasibility study of water reuse and putting the results into practice, especially (but not only) for those regions where water and sanitation services are run by different entities. There is much discussion on how water reuse projects should be managed, in particular who should take the leadership and how the responsibilities liabilities should be divided. The adoption of suitable ownership structure for the project is all a question of local circumstances, political will, legislation, institutional structure and Regulation.

5.2. ENVIRONMENTAL IMPACTS

Wastewater reuse can have two important benefits. The most obvious is the provision of an additional dependable water resource. The second is the reduction of environmental impacts by reducing or eliminating wastewater disposal, which results in the preservation of water quality downstream. Therefore, when considered in the framework of an integrated water management strategy at a catchment scale, the benefits of wastewater reuse should always been assessed taking into account that it contributes to both enhancing a region's water resource and minimising its wastewater outflow. In addition, using reclaimed wastewater for irrigation can reduce the need for fertilizer thanks to the nutrients it contains. This may even remove the need for tertiary wastewater treatment in sensitive areas.

Nevertheless, the environmental impacts of the agricultural purposes water re-use include risks to human health via the indirect consumption of or exposure to pathogens, heavy metals and harmful organic chemicals contained within it, to groundwater due to heavy metals, increased loads of nitrate and organic matter contained in it in areas where reuse for irrigation is practiced, to the soil due to heavy metals and salt accumulation and acidification, to crops due to the presence of certain substances in the wastewater in such concentration that are toxic, to the environment due to high concentration of toxic substances and need to store treated wastewater during the season when irrigation is not practiced.

5.3. ECONOMIC IMPACTS

Financing is perhaps the major barrier to a wider use of treated wastewater. In the EU financing of up-front costs was originally provided by (local) Government grants while revenue programs were financed by end users, i.e., on a commercial basis. Recent trends are that only a portion of the up-front cost is paid through grants (generally up to 50% of the approved cost) and that the water reuse project has to provide the balance.

For the demand and supply prices to match, targeted, time-bound subsidies are important and necessary. The subsidy is generally aimed at allowing the project to operate on a commercial basis while reaching a certain public program objective. One of the reasons why water supply benefits alone cannot cover the project costs is that there still exist distortions of the water supply market.

However, even when the cost recovery principle is applied, externalities such as for instance the scarcity of water and the marginal cost of new sustainable sources of water, e.g., where existing sources are their sustainable limit, are rarely accounted for. Similarly, the financial, social and environmental burdens of effluent disposal to the environment are rarely considered in the economic analysis.

Water reuse projects have also benefited from several types of specific financial incentives, although to a lesser extent. The EU does not have specific subsidies to encourage water reuse, but EU financial institutions play a key role in promoting water reuse schemes.

On a case-by-case basis several schemes have benefited from EU subsidies. The predominant programme objective is the creation of a framework that supports innovation and competition. The current transitional phase of the European water management represents a unique opportunity to correct market distortions while providing, together with water reclamation, a cheaper alternative to applications not requiring drinking water quality. It is worth noting that EU member states will have to promote cost recovery policies ensuring adequate incentives for users to exploit water resources efficiently by 2010 as established in Council Directive establishing a framework for community action in the field of water policy (2000/60/EC).

Cost-benefit comparisons should be made that compare total cost for integrated water resources management alternatives, rather than considering simply for cost before and after the project. Moreover, as the costs and benefits of a project are shared among different groups, there is a need for clearer institutional arrangements for the distribution of the effects (externalities) of the projects. Take as an example the possible pollution abatement solutions for the Nete River catchment (Belgium) the water reuse option may be (much) cheaper when looked at from an holistic point of view, still the sharing of benefits and cost among the stakeholders is very different than with the conventional option. It is not ethically and economically possible that water reuse consumers have to bear all the costs for the benefits generated by the project.

Even if the authorities promote the application of all the sustainability principles, no rules and no incentives will work without a general acceptance of the stakeholders, i.e., the water and sanitation companies, the community and the consumers alike. Otherwise even basic sustainability principles may be disregarded. Take the cost recovery rule imposed by the WFD: in a water scarce area, for instance, the regional environmental ministry now imposes a water tariff in accordance to the cost recovery principle while the Agricultural Ministry supports farmers in the form of subsidies to compensate for increased water costs. This approach maintains the situation with water resources management in the region — including the attractiveness of water reuse — practically unchanged.

Water reuse projects are often undervalued when compared to other projects due to the failure to properly quantify benefits of reuse such as watershed protection, local economic development, and improvement of public health. Engineers who are evaluating project alternatives often compare only the financial costs of various alternatives and do not quantify either social costs or social benefits.

As a result, the true benefits and costs of many water reuse projects have never been properly evaluated. If the non-monetizable benefits could indeed be quantified, the benefits of many water reuse projects would exceed the costs and, using benefit/cost ratio as an evaluation tool, would become economically feasible.

Providing reclaimed water frequently costs more than potable water system costs; however, many utilities price this water below the cost of service in order to promote its use. These revenue shortfalls must be subsidized as population growth in certain areas strains water supplies and water reuse gains popularity.

This will likely change as readily available water becomes more scarce and the public demonstrates an increased willingness to pay for dependable water supplies. Several surveys have been conducted which show that reclaimed water costs compare favorably with those of alternative sources.

As noted earlier, some of the benefits of water reuse are infrequently recognized and almost never calculated. Water recycling projects have the potential to extend existing water supplies, lessen the demand on sensitive water bodies, lower the cost of developing new water supplies, reduce wastewater treatment and disposal costs, lessen the discharge of pollutants to the environment, and provide a high-quality supply of water to serve a variety of beneficial uses. Another benefit is that recycled water can be developed in phased project expansions, which offers tremendous flexibility as to timing of water supply investments.

When future reuse projects are implemented, municipalities will be able to reduce spending on water and wastewater infrastructure, saving nearly as much as the project cost. In some cases, the cost of the water produced by the reuse technology will be less than that of other new water supplies and will take about half of the energy currently required to bring imported water to the water district.

6. CONCLUSIONS AND KEY RECOMMENDATIONS

Most of the northern European countries have abundant water resources and they all give priority to the protection of water quality. In these countries, the need for extra supply through the reuse of treated wastewater is not considered as a major issue, but the protection of the receiving environment is considered important. However, industry is generally encouraged to recycle water and to reuse reclaimed wastewater.

The situation is different in the southern European countries, where the additional resources brought by wastewater reuse can bring significant advantages to agriculture (e.g. crop irrigation) and tourism (e.g. golf course irrigation). Therefore, considering its various potential benefits, wastewater reclamation and reuse can be applied to the advantage of both northern and southern European countries (protection of water resources, prevention of coastal pollution, recovery of nutrients for agriculture, augmentation of river flow, savings in wastewater treatment, groundwater recharge, and sustainability of water resource management, etc.

Taking all this into account, it would be highly recommended to set up EU best practices and Guidelines related to the reuse of treated wastewater. Such criteria and/or Guidelines should contribute to a better management of water resources, a better protection of public health and of the environment and to a more sustainable development. The path of water reuse will certainly be followed by many regions in Europe. Within the European Union, the countries with Existing country/regional water reuse criteria are Belgium, Cyprus, France, Spain and Italy.

There already some Guidelines outside the EU on which the Regulations Entities could lean on as a departure point:

- WHO Guidelines:

  The overall objective of these Guidelines is to encourage the safe use of wastewater in agriculture and aquaculture in a manner that protects the health of the workers involved and of the public at large. In this context “wastewater” refers to domestic sewage and municipal wastewaters that do not contain substantial quantities of industrial effluent; Health protection considerations will generally require that some treatment be applied to these wastes to remove pathogenic organisms. Other health protection measures are also considered, including crop restriction, waste application techniques and human exposure control.

  The Guidelines are addressed primarily to senior professionals in the various sectors relevant to wastes reuse, and aim to prevent transmission of communicable diseases while optimizing resource conservation and waste recycling. Emphasis is therefore on control of microbiological contamination rather than on avoidance of the health hazards of chemical pollution, which is of only minor importance in the reuse of domestic wastes and is adequately covered in other publications. Purely agricultural aspects are considered only in so far as they are relevant to health protection.

  http://www.who.int/water_sanitation_health/wastewater/gsuww/en/.

- California Recycled Water Regulations and Guidance:

  Where there are several Regulations either approved or under preparation considering the final use that the recycled water is going to have such as Title 22 of the California Code of Regulations (CCR), Title 17 code of Regulations and Title 17 of the California Code of Regulations (CCR). Las update has been don on the March 28, 2013.

  http://www.cdph.ca.gov/healthinfo/environhealth/water/pages/waterrecycling.aspx,

  http://www.cdph.ca.gov/certlic/drinkingwater/Documents/Lawbook/RWRegulations-01-2009.pdf

- Australia Regulation and Guidelines considering:

  - NWQMS Australian Guidelines for Water Recycling: Stormwater Harvesting and Reuse - July 2009
  - NWQMS Australian Guidelines for Water Recycling: Managed Aquifer Recharge - July 2009
  - NWQMS Australian Guidelines for Water Recycling: Augmentation of Drinking Water Supplies - May 2008
  - Overview Document - Australian Guidelines for Water Recycling: Managing Health and Environmental Risks - Phase 1 - Mar 2004.
  - NWQMS Australian Guidelines for Water Recycling: Managing Health and Environmental Risks - Nov 2006
  - Recycled Water Quality: A guide to determining, monitoring and achieving safe concentrations of chemicals in recycled water - Uniquest - May 2006
  - NWQMS Australian Guidelines for Water Recycling - Erratum - Dec 2006
  - NWQMS Australian Guidelines for Water Recycling - Managing Health and Environmental Risks - Impact Assessment - Sep 2005
  - NWQMS Australian Guidelines for Water Recycling: Augmentation of Drinking Water Supplies - Erratum - Nov 2008

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