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Reuse of Waste Water To Solve The Problem Of Scarcity And Prevent Overexploitation Of Fresh Water Resources

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Abstract

Water is indispensable for all ecological and societal processes. Even now, one third of today's global population has insufficient access to clean drinking water. To provide effective solutions to this problem, several observation platforms, methods, models and technologies have been developed to balance water reserves, to tap undiscovered sources and to reuse resources such as wastewater. In this paper, the focus is on reuse of water in the Circum-Mediterranean region, as even now many regions of the Southern and Eastern Mediterranean are struggling with water scarcity and the overexploitation of natural renewable water resources. The aim is to assist with a more efficient reuse of water from scarce resources and therefore make more out of the little that is available. Various benefits of water reuse are also explained in this paper.

Keywords: *Water Scarcity, Water Scarce Regions, Waste Water, Circum-Mediterranean Region*

INTRODUCTION

Freshwater is no longer taken for granted as a plentiful and always available resource. More and more people in more and more countries, among which EU is not an exception, are experiencing droughts – as individuals in their day-to- day lives and as communities and nations.

Today, many European countries are subject to waves of water deficit that affect their inhabitants and the ecosystems they depend on. Events have further demonstrated how socio-economic factors, driving the demand for water, have even made the wettest parts of Europe vulnerable to drought.

In addition to drought impacts, overexploitation of water resources in some European countries and in the Mediterranean in general, especially for agriculture, increases the risk of water deficit and, consequently, environmental hazards. With reference to water resources, the ongoing destruction and degradation of water ecosystems and aquifers has already led to dramatic social repercussions. Unsustainable consumption and production patterns are degrading ecosystems and reducing their ability to provide essential goods and services to humankind. Reversing this threat and achieving sustainability will require an integrated approach in order to manage water, land and ecosystems, one that takes into account socio-economic and environmental needs.

The problem of water deficit resulting from resource overexploitation is further exacerbated by global warming which is likely to increase the variability of precipitation patterns, thereby changing the patterns of water availability in Europe on a quantitative, temporal and/or regional basis.

Reclaimed water is an alternative water resource. Water reuse can be a tool in managing scarce water resources. Recycled water is being used as substitute for many traditional non potable uses and for sources that provide raw water for drinking water production (table 1). Such use can help conserving drinking water by replacing it or the water taken from drinking water sources, and by enhancing sources such as reservoirs and groundwater. The improvements in treatment of wastewater have opened new possibilities to reuse treated wastewater. Hence, the indirect recycling of water used in many parts of the world has been largely practiced for many years. There are no formal european wide guidelines, best practice or regulations for water recycling and reuse other than the Urban Wastewater Directive which requires that "treated wastewater shall be reused whenever appropriate". Disposal routes shall minimize the adverse effects on the environment" (article 12). The EU needs suitable guidelines and definition of "whenever appropriate". This should however be seen in the light of the objectives of the directive (article 1) : "…to protect the environment from the adverse effects of waste water discharges". Significant progress has been made through initiatives in some member states. To maintain the momentum gained, the valuable initiatives in Cyprus, Belgium, France, Spain, UK and other countries

Table 1: Water recycling and reuse definitions

	Definition
Reclaimed water	Treated wastewater suitable for beneficial purposes such as irrigation
Reuse	Utilization of appropriately treated wastewater (reclaimed water) for some further beneficial purpose
Recycling	Reuse of treated wastewater
Potable substitution	Reuse of appropriately treated reclaimed water instead of potable water for non potable applications
Non-potable reuse	Use of reclaimed water for other than drinking water, for example, irrigation
Indirect recycling or indirect potable reuse	Use of reclaimed water for potable supplies after a period of storage in surface or a groundwater
Direct potable reuse	conversion of wastewater directly into drinking water without any intermediate storage

should be used as a base to develop water recycling and reuse guidelines and codes of best practice. The potential of reuse in Europe is high, especially in Spain, Italy, and to a lesser extent in France, Portugal, Greece, Poland and Belgium. For example in Spain, a maximum water reuse of 2000 Mm3 /year could be reached (Hochstrat et al., 2005).

APPLICATIONS

Although treated wastewater has been an important mean of replenishing river flows in many countries and the subsequent use of such water for a range of purposes (figure 1) constitutes indirect reuse of wastewater, it is becoming increasingly attractive to use reclaimed or treated wastewater more directly. In addition, reclamation of wastewater is attractive in terms of sustainability since wastewater requires disposal if it is not to be reclaimed (UKWIR et al., 2004).

Treated wastewater may be used as an alternative source of water for agricultural irrigation. Agriculture represents up to 60 % of the global water demand while the requirements arising from increasing urbanization such as watering urban recreational landscapes and sports facilities, also creates a high demand : water scarcity in Mediterranean countries historically led these countries to appropriately use treated wastewater in agriculture, irrigation of golf courses and other green spaces, including those used

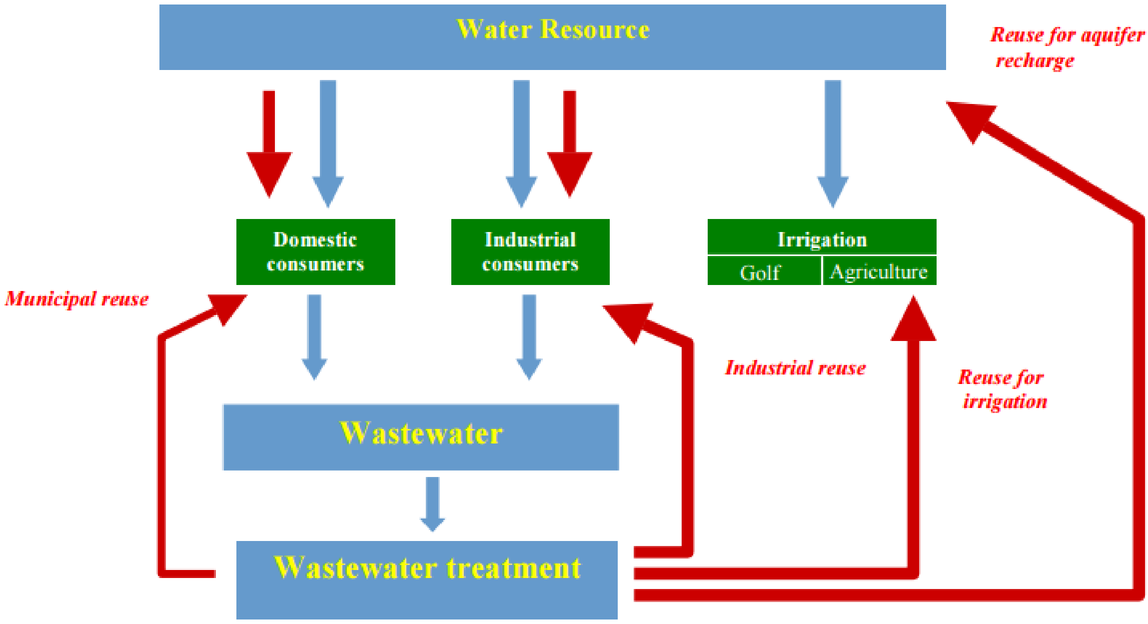

Figure 1: Different applications of reuse

for recreation in which individuals may come into contact with the ground. It can be used to supplement artificially created recreational waters and for reclamation and maintenance of wetlands for which there can be a significant ecological benefit and a subsequent sense of profit to the community. Concerns related to the reuse of treated wastewater are similar to the reuse of sludge, in particular the risks of contamination. Treatment plants are typically only equipped for biological treatment which does not eliminate the chemical substances in the waste water.

In urban environments, treated wastewater may also be used for fire-fighting purposes or street cleaning. In industry, the use of recycled or reclaimed water has extensively developed since the 1970's, for the dual purpose of decreasing the purchase of water and avoiding the discharge of treated wastewater under increasingly stringent emission regulations. This trend started with wash water recycling but now incorporates the treatment of all types of process waters. Virtually, all industrial sectors are now recycling water, with examples in pulp and paper, oil refinery, etc. Consequently, together with overall shifts in the industrial sector, a 30 % reduction of industrial water consumption has been achieved in some european countries (website ref 1). Where water is scarce, industries also use reclaimed municipal water to reduce their production costs. An additional use may be the direct supplementation of drinking water resources through groundwater infiltration and by adding it to surface water, with examples in northern Europe where several cities rely on indirect potable reuse for 70 % of their potable resource during dry summer conditions. It is even technically possible to use reclaimed water as a direct drinking water source, although acceptability of the public may not be achievable yet. The first priority to consider, with regards to the benefit and the public acceptance, is the recharge of surface and groundwater bodies. This form of indirect reuse is a common practice: artificial recharge of groundwater for saline ingress control, or potable resource enhancement, such as in Flanders. Potable substitution is the second priority for any non potable application such as:

- reclaimed water for industry (for cooling water make up, process water to reduce manufacturing costs

- agricultural and urban irrigation, to increase productivity and increase the value of amenities such as parks, sports fields, golf courses as well as domestic gardens on new developments, and finally agriculture itself.

PUBLIC HEALTH AND ENVIRONMENT PROTECTION

The protection of public health is the key issue associated to water reuse. In addition to public health risks, insufficiently treated effluent may have detrimental effects on the ability to grow irrigated crops. The main risk associated to reuse in irrigation is a short-term hazard associated to the presence of pathogens in the water. The World Health Organisation (WHO) has set guidelines for water reuse in irrigation, mainly based on fecal coliforms and helminth eggs counts, with quota adapted to the use for crops.

In Europe, a few member states (where reuse is necessary for irrigation, like in Spain, Belgium, Italy and France) had to overcome the absence of european guidelines or regulation by creating their own national regulation. These standards are based on the WHO guidelines and necessary conservative assumptions, the later leaving room for extremely severe requirements. It is worth noting that, in contrast with some other standards such as the Californian Title 22, member states standards for reused water are not based on technology.

For direct or indirect drinking water supply, the Directive 98/83 is applied with very strict standards for pathogens and chemical contaminants, therefore offering a high level of public health protection. There is however some concern that the current standards and guidelines were not designed to deal with the mixture and individual contaminants that are unique to wastewater sources and water catchments recharged with treated wastewater. Endocrine disruptors, pharmaceuticals, disinfection byproducts and pathogenic bacteria, viruses and parasites, and genetically engineered products might be present at levels relevant to public health.

Hence, beyond the strict legal requirements for compliance with maxima designed for various types of uses, there is a shift towards water safety plans which are based on a risk assessment of the entire water cycle from source to final user. This incorporates a thorough analysis of the raw water quality parameters and protection measures, the individual treatment steps, their capability to remove the targeted pollutants, and the distribution system up to the point of use. This methodology uses the Hazard Analysis and Critical Control Points (HACCP) approach where the multiple barriers appear as the preferred approach to minimize risks to an acceptable level, in addition to the complementary water quality control.

The opportunities for water reuse should also avoid or minimize environmental impacts to biological, hydrogeological and cultural resources, and to land use due to the construction or operation of reuse facilities.

TECHNOLOGIES

All types of technologies are used to reclaim wastewater, depending on the initial pollutant type and concentration, and treated water quality to be achieved. Stringent control of water quality and operational reliability are the main requirements which drive the technological choices. The most well- known example of reuse in Europe is the supply of drinking water through bank filtration, where the local geology (soil aquifer treatment) and land protection regimes authorize the use of surface water situated downstream of wastewater treatment plants. In such cases, the natural processes taking place in the bank safely remove the pollutants and pathogens. Whenever needed, these natural processes may be complemented by filtration on granular activated carbon for pesticides and ozonation for micro-pollutants removal.

One third of the water reclamation schemes relies on secondary treatment of municipal sewage. This level of treatment usually fulfils the requirement of cooling water in the industry, or irrigation water where the food crops are consumed after cooking. One has to mention the possibility offered by membrane bioreactors, which can replace the secondary treatment, while enabling to meet disinfection requirements. Other advanced treatment may replace traditional secondary treatment for reuse purposes.

More often, some kind of tertiary treatment is required to meet the industry or irrigation standards, especially in the later case where disinfection is needed. Disinfection may be achieved by oxidation with chlorine, ozone, or more recently ultraviolet irradiation. Granular activated carbon is used where micro-pollutants are likely to be present.

The last case involves a quaternary treatment with membranes. The most common processes involve either microfiltration (pore size of 0,1 µm) or ultrafiltation (pore size of 0,01 µm), which also removes viruses. These treatments are the favourite technologies on sewage for the removal of suspended solids, particles, bacteria and parasites. In addition, nanofiltration (pore size of 0,001 µm) or reverse osmose membranes (pore size of 0,0001 µm) are used when soluble materials such as salts or dissolved organic matter have to be removed, in order to achieve drinking water quality or ultra pure water quality for industry.

A combination or hybridization of different centralized or decentralized technical solutions is needed to reach the specific objectives when considering the local water cycle. The issue is not the availability of technology but the vision, experience and institutional infrastructure needed to recognize and implement reuse solutions. These needs to build on the synergy between natural and technological solutions that protect public health and the environment, reduce costs and energy demand to treat and transport water.

In the interest of managing both known and unknown risks, advanced water treatment processes are increasingly being deployed in recycled water projects to provide added assurance that unknown risks are mitigated.

WATER REUSE BENEFITS

Water reuse benefits all segments of the anthropogenic water cycle and should be considered as an horizontal application that pulls together the normally segregated disciplines of potable water and wastewater treatment for economic development, public health and environmental protection. Water reuse reduces the competition for water between agriculture, public and industrial supplies by increasing the available water resource and can be used as an effective cohesion tool across Europe. Water reuse benefits are:

1. Decrease of net water demand and value addition to water

2. Potable substitution : keep potable water for drinking and reclaimed water for non potable use

3. Lower energy costs compared to deep groundwater, importation or desalinization

4. Reduction of manufacturing industries costs by using high quality reclaimed water

5. Valuable and drought proof alternative water for industry and irrigation

6. Reduction of nutrient removal costs to protect the surface waters through irrigation

7. Reduction of nutrient discharge to the environment and loss of freshwater to the sea

8. Increase of land value when developing brown field sites and with drought proof irrigation

9. Increase of local ecological benefits, flood protection and tourism through the creation of wetlands, urban irrigation, bathing beach protection and reduction of the need and cost of long sea outfalls

10. Control of the problems of over-abstraction of surface and groundwater

11. Management of the recharge of surface and groundwaters to optimize quality and quantity

12. Integration of all parts of the anthropogenic water cycle to enable cohesion between all regulators and industries across Europe.

CONCLUSION

It is essential that the development of water recycling and reuse in agriculture and other sectors be based on scientific evidence of effects on environment and public health. The EU needs a regulatory and institutional framework tailored to suit local needs to take advantage of the water recycling and reuse opportunities, and to help overcome the water shortage problems regarding cost-effectiveness. It appears necessary to provide a comprehensive guidance document to ensure that any risk is minimized and that valuable knowledge is available for any organisation considering the implementation of a water reuse project.

Water scarcity solutions need to include economically justifiable water saving and demand management techniques rather than immediately searching for new water resources. Water reuse is one of a large number of alternative solutions but is important when considering the objectives of the Water Framework Directive as water reuse is proven to increase water availability and reduces surface water eutrophication. Agenda 21 and the widely agreed need to recycle waste materials are dynamically being promoted and implemented across Europe. It can be argued that water recycling has a higher impact on European sustainability than paper, glass and metals recycling and Europe does not have guidelines yet to help innovators to sustainably recycle water.

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