

## WATER RECYCLING AND REUSE IN EUREAU\* COUNTRIES. TRENDS AND CHALLENGES

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## **ABSTRACT**

Europe depends on appropriately treated wastewater to protect the environment and ensure that freshwater is available for all applications. Water recycling and reuse through surface and groundwater bodies is common practice and public health is protected through potable water standards. The reuse of water for non potable applications or potable substitution has been proven internationally in water stressed regions to be a drought proof source of water and one of the most effective water scarcity solutions.

This paper considers

- the status of water reuse in Europe,
- the challenges
- what should happen in the future
- examples of successful regions and not so successful regions in Europe

**Key Words:** water reclamation, drought proof, potable substitution

## **INTRODUCTION**

Water reuse or recycling is of vital importance to Europe because it:

1. increases the water resource available
2. reduces eutrophication
3. can reduce cost and lower energy demand (subject to application)

Water reuse is a water scarcity solution and the issues above are some of the biggest drivers in the Water Framework Directive. Perhaps the problem is that water reuse is one on the most misunderstood water applications just in the same way that the anthropogenic water cycle is not well understood? Perhaps we are not communicating well enough?

UN Agenda 21 states that we need to “maximise environmentally sound waste reuse and recycling”

The Bureau of International Recycling (BIR) states that the world is moving steadily into the age of conservation with recycling as an integral part. And yet recycling is not new. Without recycling, the circle merely becomes a series of events without a logical resolution. Potentially useful materials become a hazard rather than being retained as a resource.

Recycling conserves raw materials. It also saves energy and protects the environment. The BIR web site confirms their industry has:

- 1.5 million employees in more than 50 countries
- an annual turnover exceeding 160 billion US dollars
- the industry processes over 600 million tonnes of commodities

The paper industry is a major water user and they state that recycled paper has a 64% lower energy demand compared to primary production. Producing from recycled paper means 35% less water pollution and 74% less air pollution. [BIR]

Unfortunately water is not part of BIR recycling interest. Perhaps we could learn from their communications so that we can clearly demonstrate what water reuse is and why it's important.

### **Water Scarcity**

We take water for granted until the tap is dry. The dry winter of 2004, the dry spring and summer of 2005 is highlighting the dramatic impact of drought and the need for a European Drought management strategy. The impact of drought can be greatly exacerbated by the inefficient use of water, inadequacies in infrastructure, water use, demand management and in legislative frameworks and regulatory mechanisms. The economic impact of droughts has been approximately 25 billion Euros over the last 30 years and was nearly 12 billion in 2003. Research has shown that the worst drought in the USA was more than twice the cost of the worst flood [EURAQUA]

Water stress is also increasing due to population density, diffused pollution and short-term seasonal population increases due to tourism and increased demand for irrigation to improve agricultural productivity. At the same time, the Water Framework Directive requests an analysis of water use, which in some regions or basins could lead to a reduction of 15 to 20% of abstraction licenses, in order to protect surface and groundwater quality and quantity. The need for alternative sources of water was emphasized by the 2003 drought which resulted in a 30% reduction in agricultural production. This drought was a dramatic example of the measured 20% reduction in annual precipitation from 1900 to 2000.

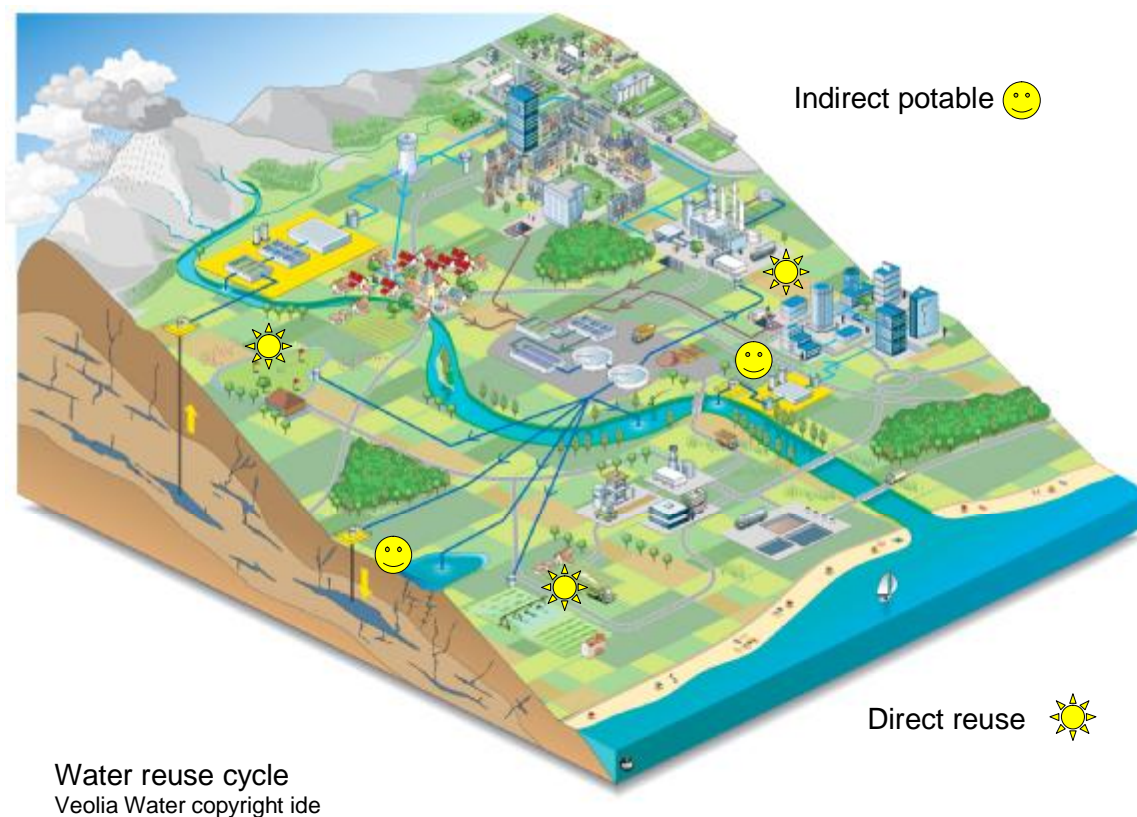
**The Water Directors** who represent each of member states of Europe and decide on European water priorities recognise the importance of drought. As a result a "Best practices on water scarcity" document is being prepared by a team being led by the French, Italian governments with co drafters from the EU member states, Mediterranean and non EU countries (Egypt & Tunisia) as well as DG Research, DG JRC, ARID cluster, EUREAU and the WWF. Water reuse as a well proven, if not well understood, water scarcity solution was raised under any other business at the last Water Directors meeting in Luxemburg and water reuse is on the agenda for the next Water Directors meeting in November 2005 in London. **This is probably the greatest opportunity for Europe to start to understand and benefit from water reuse that we have had in the last ten years.**

### **WATER REUSE STATUS IN EUROPE**

Although treated wastewater has been an important means of augmenting river flows in Europe and the subsequent use of such water for a range of purposes 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 2004). There are several cities in northern Europe that rely on indirect potable reuse for 70% of their potable resource during dry summer conditions.

The Aquarec project has identified over 200 water reuse projects in Europe out of 3,300 water reclamation projects globally. The review considered seven geographical regions: a) North and b) Latin America, c) Europe, d) Mediterranean Region and Middle East, e) Sub-Saharan Africa, f) Oceania and g) Japan. Japan has the largest number of reuse project (over 1,800), followed by the USA (over 800), which is the largest producer, with a volume of reused water estimated at close to 6.5 Mm<sup>3</sup>/d. Almost 100 sites were identified in the Mediterranean and

Middle East area, with more than 50 in Latin America and 20 in Sub-Saharan Africa (Bixio et al. 2005).



**Figure 1** Reuse water cycle diagram. (Veolia Water. copyright idé communications agency)

The number of municipal water reclamation facilities identified throughout the world – sorted by application – is shown in Figure 2. The applications are split in five categories: a) agricultural irrigation; b) urban, recreational and environmental uses, including aquifer recharge; c) process water for industry; d) direct and indirect potable water production; e) combinations of the above (mixed).

Note that these numbers are destined to become quickly outdated as many projects were identified at an advanced planning phase.

In 2004 it is estimated that 700 Mm<sup>3</sup>/yr of water was reused in Europe which is less than a fifth of the estimated potential for water reuse. The AQUAREC project developed a model-based approach which is able to quantitatively assess the potential for wastewater reuse using effluents from wastewater treatment plants. The approach was applied to quantify the European water reuse potential and compared well to existing estimates.

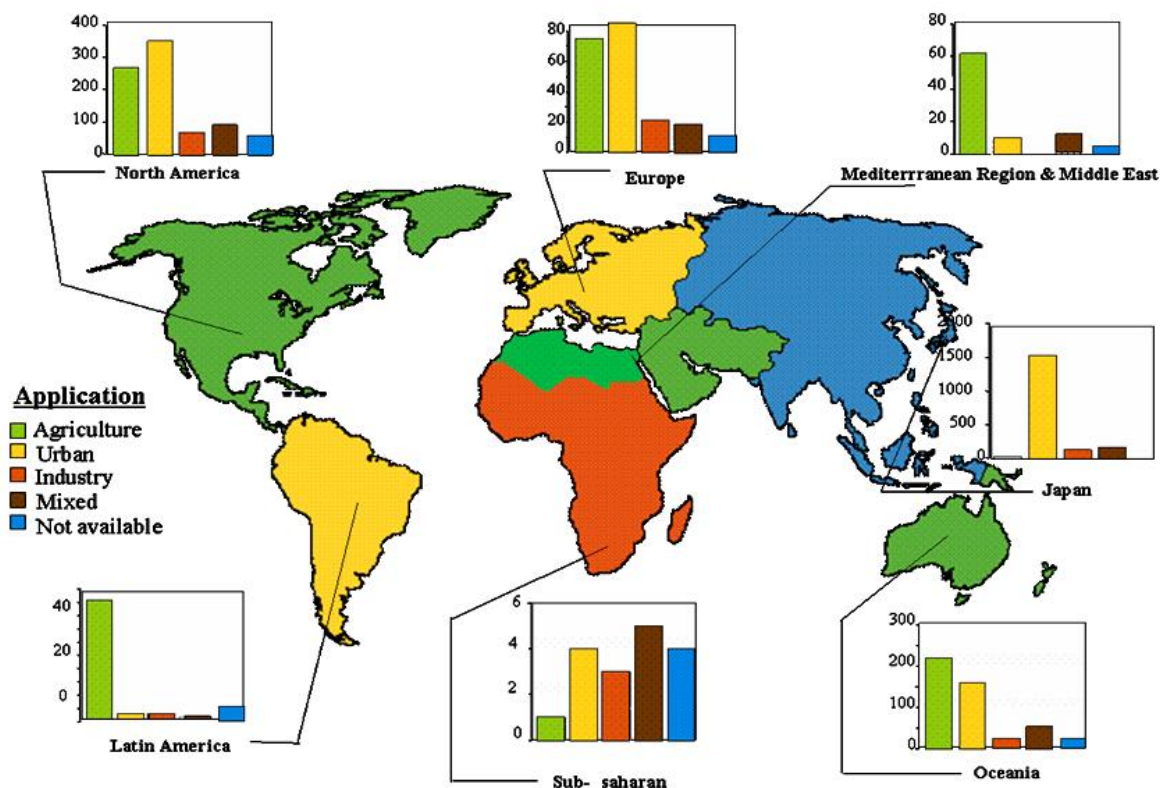


Figure 2. Number of water reuse projects distributed according to their application (adapted from Bixio et al. 2005a).

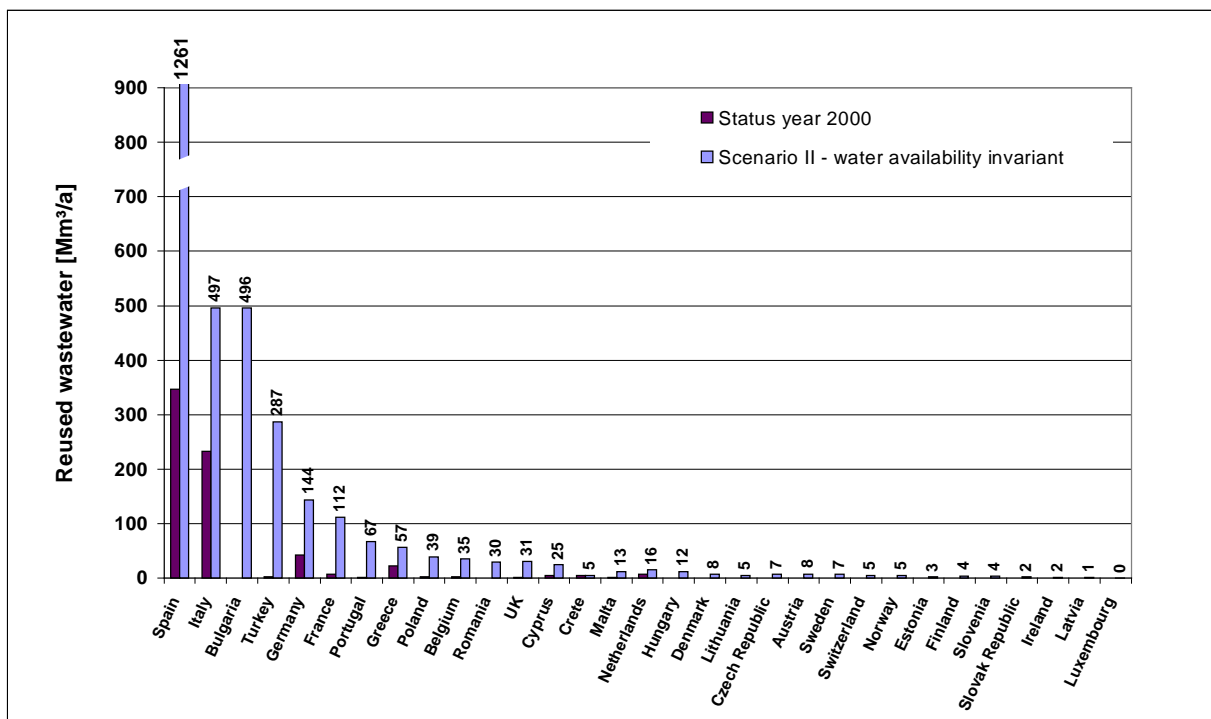


Figure 3. Model output for wastewater reuse potential of European countries; projection horizon 2025 (Hochstrat et al. 2005).

Figure 3 illustrates that Spain shows by far the highest reuse potential, the calculations suggesting a value of over 1,200 Mm<sup>3</sup>/yr. Italy and Bulgaria both exhibit estimated reuse potentials of approximately 500 Mm<sup>3</sup>/yr. Wastewater reuse appraisals for Turkey amount to

287 Mm<sup>3</sup>/yr, whereas Germany and France are supposed to reuse 144 and 112 Mm<sup>3</sup>/yr respectively. Portugal and Greece account for reuse potentials of less than 100 Mm<sup>3</sup>/yr (67 and 57 Mm<sup>3</sup>/yr). Overall, the estimates suggest a wastewater reuse potential of 3,222 Mm<sup>3</sup>/yr (Hochstrat et al. 2005).

It is essential that the development of water reuse in agriculture and other sectors be based on scientific evidences of its effects on environment and public health. Although several studies have been conducted on wastewater quality and for different purposes, at this time, there are no guidelines, best practice or regulations of water reuse at an EU level other than the Urban Wastewater Directive which states that “treated wastewater shall be reused whenever appropriate”. Further work is needed to develop the suitable guidelines and definition of “whenever appropriate”. The valuable regional initiatives in Spain, France, Belgium, UK and other countries could be used as a base to develop water reuse guidelines.

The 15 European countries with the highest estimated increase in water demand include North Western, Central and Southern Europe. The conservative interim estimates of growth from 2000 to 2025 range from 1.3 to 14 fold increase in capacity with an average of 2 fold increase. This current and conservative estimate of water reuse activity in Europe emphasises the need for clarification of the appropriateness of water reuse through water quality and best practice guidelines (EUREAU 2004). Water reuse and potable substitution can increase the availability of water for public water supplies. This includes northern countries where authorities are also experiencing water stress. In London the population density and the rainfall of 690mm per year results in the water availability of only 265m<sup>3</sup>/capita/year demonstrating the need for alternative sources of water (Planet Water 2003).

The European water abstraction average data states that public water supply is 18%, agriculture 30%, industry 14% and electricity industry 38% (EEA 2000). However, if we agree that the majority of the electricity industry (cooling water) abstraction is returned rapidly to the surface water then the water abstraction for public water supply accounts for approximately 70% of the total water demand. Potable substitution through water reuse can potentially have an even greater impact on water resource availability if we consider the 70% of water abstracted for public water supply rather than the 18% normally considered. In southern Europe approximately 70% of the abstraction is for irrigation. This is a well proven potable substitution application that reduces the demand on freshwater that is treated for potable supplies.

The ARID CLUSTER water scarcity workshop in 12-13 May 2005 in Cyprus was titled “Coping with Drought and Water Deficiency: from research to policy making” presented the results of the EU research projects on integrated and sustainable water resource management. ARID is a cluster of EC under the FP5 projects dealing with water resources use and management in arid and semi-arid regions. The ARID cluster operates by linking thematically complementary projects via (a) project web pages; (b) cross-representation; (c) exchange of data; (d) joint meetings; and (e) workshops. (Arid Cluster 2005).

The ARID cluster includes three research projects on integrated and sustainable Water Resources Management:

- § WaterStrategyMan (Developing Strategies for Regulating and Managing Water Resources and Demand in Water Deficient Regions)
- § Medis (Towards Sustainable Water Use on Mediterranean Islands: Addressing Conflicting Demands and Varying Hydrological, Social and Economic Conditions)

§ Aquadapt (Strategic Tools to Support Adaptive, Integrated Water Resource Management under Changing Utilisation Conditions at Catchment Level: A Coevolutionary Approach)

The EUREAU reuse group were asked to present a paper on “water recycling and reuse: a water scarcity best practice solution” at this workshop. This resulted in a request for a two page summary for the EU Water Scarcity group which highlighted the importance of water reuse as a water scarcity solution and the priorities for safe implementation. The second page of this summary stated the following:

**What are the key priorities that will enable water reuse projects to be implemented safely in Europe?**

1. Agreement of the need for reuse and the need for guidelines rather than regulation. (It has been argued that it is more important to create an environment to favour water reuse where some technology is needed, there is appropriate monitoring, user pays the production costs and the costs are transfer to the plant operator, etc. than simply having a set of regulations.)
2. Provide a comprehensive guidance document to ensure any risk is appropriately minimised and valuable knowledge is available to any organisation considering implementing a water reuse project
3. Society / stakeholders must be involved so that they understand and fully contribute to the decisions
4. Safety of the product and the systems has to be proven
5. The solutions must be justified and sustainable from environmental, economic and social aspects

**How can this be achieved?**

1. Guidance and best practice document on water reuse published as an appendix to the Urban Wastewater Directive and cross referenced in the other relevant parts of the Water Framework Directive and the Drinking Water Directive
2. Clear and accurate documents published on the anthropogenic water cycle to overcome the lack of understanding between drinking water, wastewater, water resource planners, environmental fraternities, politicians and the public.

**What action is recommended?**

1. A stakeholder technical committee should be created on water reuse by DG Environment to produce the guideline documents as an Annex to the Directive.
2. A workshop should be held to produce European guidelines based on the different water reuse initiatives that have been completed or are being researched across Europe. (DG Research AQUAREC and the other research projects on water reuse, EUREAU, UKWIR UK, AEAS Spain etc). The workshop should also identify gaps and research needs. The guidelines should:

- a. Accurately describe the anthropogenic water cycle
  - b. Explain clearly the benefits and risks
  - c. Provide a framework for implementation
  - d. Highlight water safety planning and good practice experience in Europe and globally with links to other international guideline documents (USA, Australia, Singapore etc)
  - e. Clearly interpret the statement in the UWWTD that “treated wastewater shall be reused whenever appropriate”
3. The stakeholder technical committee should manage the liaison with other commissions in Europe such as Public Health and Agriculture.
  4. Recommendations should be prepared on how to attract financial incentives to encourage member states to exploit water resources efficiently
  5. The guidelines should be updated on a regular basis by an approved authority to ensure that the latest experience and scientific knowledge is available
  6. The stakeholder technical committee should prepare an action plan to exploit the cohesion benefits of water reuse in Europe and the export of EU water reuse technology and expertise to support EU initiatives in developing and developed countries. (Durham B et al. 2005)

It is understood that a copy of this document is now with the UWWTD desk officer.

## **THE CHALLENGES IN EUROPE**

The challenges need to be managed as opportunities to increase the efficient and sustainability of the anthropogenic water cycle.(economic, environmental and social)

Please consider the following challenges:

- A common lack of understanding of the anthropogenic water cycle?
- Emerging public health and environmental issues
- Water is not valued
- Water price is too low to justify treatment
- Water is disposable - use it once and throw it into the sea
- Sewage or wastewater is an effluent for disposal
- Confusion about water recycling and reuse
- A lack of understanding and sometimes competition between the cultures of potable water and wastewater
- Lack of water reuse quality guidelines and best practice in Europe
- Is the hard won experience in Europe is about to retire?
- How to build champions and capacity to overcome the internal and external “departments of no”. Too busy, more important problem to solve, not enough experience to decide, too difficult, fear of risk, limited vision or leadership skills?
- How to implement a river basin management strategy without rivers?
- Regions without the experience of rivers have an irrational fear of aquifer recharge
- The need to consider surface and groundwater as the same water body unless it can be proven they are separate

- How to develop a multi-barrier water safety plan from “Source to Tap” and from “Tap to Source” with an explanation of how and when treated wastewater becomes freshwater again?
- Integrated water resource management and river basin management can imply a linear process whereas urban water is often cyclic
- Centralised wastewater treatment bypasses local rivers and aquifer recharge opportunity
- How to describe the real anthropogenic water cycle to our stakeholders without creating fear or risking brand value?

## **THE FUTURE IN EUROPE**

The Water Supply and Sanitation Technology Platform (WSSTP) was set up within the European Environmental Technology Action Plan (ETAP) that was adopted by the European Commission in 2004. It is a European initiative, open to all stakeholders involved in European water supply, sanitation and major end-user groups. The participants in the platform are producing a common vision document for the whole European water industry together with a strategic research agenda and an implementation plan for the short (2010), medium (2020) and long term (2030). The WSSTP (WSSTP 2005) will contribute to:

- the competitiveness of the European water industry (Lisbon Strategy)
- solving the European water problems
- reaching the Millennium Development Goals (Johannesburg)

Approximately 300 specialists in Europe have contributed to the five working groups which include water resource management, water for people, water for industry, water for agriculture, and cross cutting issues/enabling factors. The draft merged strategic research agenda document that summarises the key issues raised by these five working groups, highlights the importance of managing the water cycle, closure of the water cycle and water reuse. The 19 page draft summary mentions water cycle 25 times and water reuse 11 times which perhaps demonstrates that the importance of water reuse is starting to be understood by the water and environment fraternity.

### **What will be the future for water reuse in Europe?**

- Accurate anthropogenic water cycle educational material is available on the internet
- The need for water reuse and the benefits are comprehensively recognised as a normal water resource management practice and not just as a water scarcity solution
- Water quality guidelines and best practice are attached to the UWWTD. EU has in place the regulatory and institutional framework tailored to suit local needs to take advantage of the water recycling and reuse opportunities to safely maximise water efficiency. The framework includes a clear definition of the benefits for all segments of the anthropogenic water cycle. It proves that water reuse is a horizontal or cross cutting application that pulls together the normally segregated disciplines of potable water and wastewater treatment for public health and environmental protection. Case studies describe how water reuse reduces the competition for water between agriculture and public / industrial supplies by increasing the water resource available. The framework also shows how the European water reuse network and knowledge transfer has worked as a catalyst to increase European cohesion.

- New projects are being implemented using the guidelines and knowledge and experience from existing projects.
- The benefits of soil aquifer treatment (SAT) are accepted as a sustainable advanced wastewater treatment process that can play an important role in a multi-barrier indirect reuse system as demonstrated on three US projects which shows that the groundwater recharged with reclaimed water is of potable quality due to the SAT. [Amy G et al 2005].
- Project viability is based on clearly measurable environmental, social and economic benefits using whole life, sustainability and cost effectiveness tools that provide a fair way of evaluating the benefits. The EU WaterStrategyMan research project (EVK1-CT-2001-00098) [Arid Cluster 2005] has developed a manual for “valuing water in water shed in the absence of market prices: guidance for WFD Implementation”. This shows the value of environmental benefits for all water bodies in England and Wales. The table below emphasises the importance of reuse for surface water and groundwater recharge. This could be expanded to include the value of soil protection, attracting local business due to the water resource available, creating an attractive habitat / sports facilities to reduce health costs in the community.
- Projects are taking advantage of financial incentives available to build skills and confidence in each country.
- Wastewater reclamation and reuse is embedded into the integrated management of the water cycle as a water resource solution. The investment costs are funded by the water resource agency rather than as part of the wastewater treatment budget. These water resource investments are included in the cost recovery policies that the EU member states are promoting to ensure adequate incentives for users to exploit water resources efficiently by 2010 and beyond.
- Innovative projects are encouraged to promote cohesion, international leadership and export opportunities.
- The EU is implementing water recycling and reuse projects with EU technology and expertise and satisfying export

**Table 1.** Water reuse benefits

- 1 - Decreases net water demand and adds value 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 desalination
- 4 - Reduce manufacturing industries costs by using high quality reclaimed water
- 5 - Valuable & drought proof alternative water for industry & irrigation
- 6 - Reduce nutrient removal costs to protect the surface waters through irrigation
- 7 - Reduces nutrient discharge to the environment and loss of freshwater to the sea
- 8 - Increases land value when developing brown field sites and with drought proof irrigation
- 9 - Increase local ecological benefits, flood protection and tourism through the creation of wetlands, urban irrigation, bathing beach protection and reduces the need & cost of long sea outfalls
- 10 - Control the problems of over abstraction of surface & groundwater

## SUCCESSFUL AND LESS SUCCESSFUL REGIONS IN EUROPE

### Successful regions

#### Spain

There is more water reuse experience in Spain than any other region of Europe

- Canary Islands – driven by a high and perhaps more realistic value of water
- Murcia – by calculation that the economic impact to the agricultural industry of aquifer over abstraction, saline ingress and subsequent soil salinisation was 120 million US dollars per year [Latorre M 2002]
- Barcelona (Depurbaix) – probably the largest reuse project in the world with a visionary water resource management solution by combining direct aquifer recharge for control of seawater ingress with river, wetlands and irrigation to recharge the river basin aquifers.
- Costa Brava – a steady growth through a large network of water and wastewater utilities in the Consorci that have developed a large number of reuse projects in most applications by building local expertise and trust in the region.
- Vitoria – the greatest single agricultural reuse project in Europe for high-value crops with Title-22 treatment. 35,000 m<sup>3</sup>/day were supplied for irrigation of 3,500 ha in the first phase (1995-2004), whereas in the second phase the irrigated surface will be expanded to other 6,500 ha thanks to the 7 million m<sup>3</sup> reservoir just for reclaimed water recently built and that will store the reclaimed water produced off the irrigation season.

**Table 2.** Types of benefits of water reuse and their estimated value (Koundouri, P. et al, 2005)

Type of Benefit	Millions of UK Pounds/ year
Ecosystems and natural habitats – rivers & lakes	189-405
Ecosystems and natural habitats – wetlands	16-38
Angling	26-27
Bathing	20
Amenity	19
Groundwater	13
Informal recreation	6-12
Total	289-535

#### Germany

Berlin has operated like many large cities / river basins with a partly closed water cycle for hundreds of years through a combination of careful wastewater treatment and the benefits of soil aquifer treatment through bank filtration to produce potable water from the aquifers. The NASRI research project ([www.kompetenz-wasser.de](http://www.kompetenz-wasser.de)) was set up to study the fate of pathogens and organics, geochemical processes and the hydraulics of bank filtration and artificial recharge systems at laboratory, semi technical and field scale. The outstanding feature of this project is the multi-stakeholder involvement which includes the water utility with local universities and the environmental regulator.

#### Belgium

The IWVA Torreele indirect potable water reuse through dune infiltration and aquifer recharge project is providing 40% of the potable water demand. This is an outstanding achievement for one of our smallest but highly innovative European water operators. The

unusual aspect of this project is their high level of communication and involvement with the community prior to, throughout the project and during the three years of operation. This has reinforced a high level of trust and acceptance of indirect potable reuse within the community. IWVA also have a commitment to search out international experience and share their experience at leading conferences in most parts of the world. ([www.iwva.be](http://www.iwva.be)).

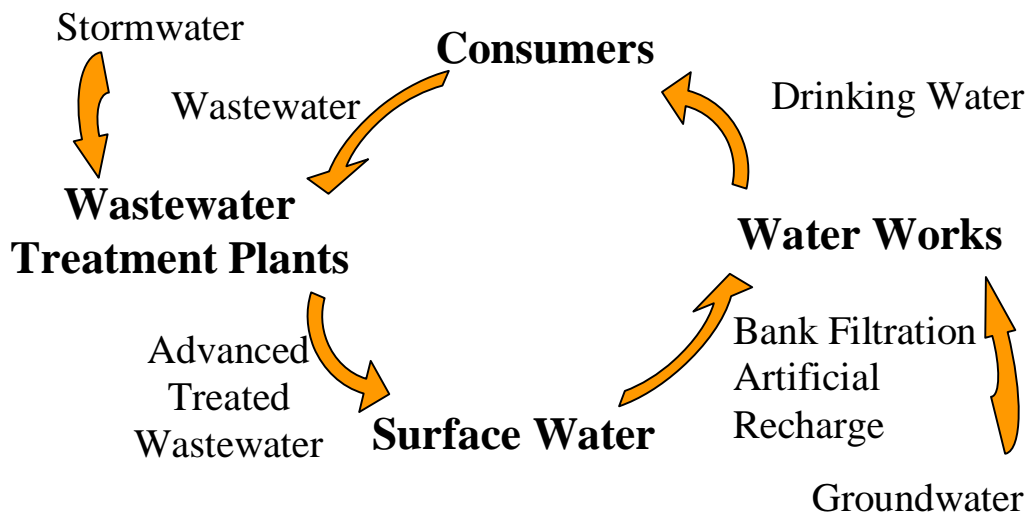


Figure 4. Schematic representation of the water cycle.

### Less successful regions

#### Country A

Unfortunately the key government regulators do not seem to understand the anthropogenic water cycle and certainly do not understand water reuse. When key workshops are organised to develop water reuse guidelines no one from the environmental regulator could justify attending. Aquifer recharge is seldom permitted and then only with potable water even though the water resources depend on treated wastewater to recharge the rivers and groundwater. A large percentage of inland rivers depend on treated wastewater for 80% of their flow during dry weather conditions and these rivers help maintain the aquifers. Municipal wastewater reuse for industry can be very difficult due to debate over who owns the water and therefore who is allowed to reuse it. Innovative solutions have to be justified to the Government on lowest possible cost without seriously considering the environmental or social value. Water reuse is generally in the “too difficult box” even though water scarcity is a serious issue. Public perception problems with water reuse are frequently used as an excuse to avoid any constructive action. Important water scarcity and water resource planning meetings are not keen to discuss water reuse. It’s probable that a crisis is needed to energise progress or the identification and development of champions with leadership skills.

#### Country B

Water scarcity resulted in the decision to build dams to maximise rainwater catchment. The government encouraged farmers to irrigate with groundwater which unfortunately was no longer being recharged by the rivers due to the dams. This has resulted in seawater ingress up to 5 km inland which will result in soil salination and the decline of the agricultural industry that the government wanted to protect. Groundwater recharge is not believed to be acceptable

due to public perception and health risks. The WFD is now being implemented with its river basin management plan with difficulty as most of the rivers have no flow.

## CONCLUSIONS

The words we use and perhaps more importantly the pictures we paint to describe water reuse is perhaps the most important issue. We have to be open, honest and professional to build trust. How do we do that when our audience does not understand the anthropogenic water cycle let alone water reuse?

China is adopting an integrated water cycle management (IWCM) strategy having looked at the different approaches around the world. They say that they are also changing their institutional and regulatory framework to avoid overlapping regulation, confusion and to encourage IWCM to happen. One of the key parts of IWCM is water reuse.

We need to promote professional and clear communication documents. We must promote easy ways for guidelines and best practice to be added to the UWWTD without creating excessive workload or “too difficult” barrier. These guidelines must make it easier for the next important projects like Depurbaix in Barcelona or Torreele in Flanders to be implemented with the advantage of proven European best practice.

The greatest challenge we have is building a network of champions and Government capacity in the European market so that justifiable projects can be implemented. EUREAU were told that there would be no progress on reuse in Europe unless the Water Directors added reuse to their agenda. We know reuse has been added to the agenda for their November meeting in London. We need as many Water Directors as possible championing the benefits of water reuse at that meeting as we may not get this chance again.

Our challenge now is to decide how we most effectively communicate the importance and benefits of reuse to each of the Water Directors so that we do not waste this opportunity.

## ACKNOWLEDGEMENTS

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