



**Thematic Week:** Water services for supply and sanitation

**Thematic Axis:** Technological capacity, determining factors and solutions

**Title:** *Recycling wastewater, a solution to contribute to sustainability in water*

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**Abstract:**

New shortages call for the invention of new resources. Wastewater, that so-called “*hostile water*,” is now deemed to be useful. Alternative resources provide room to rethink water management in regions stricken by hydric stress. Wastewater recycling is a tried-and-tested solution for producing water suitable for industrial, agricultural and even domestic use, and then, for achieving a greater sustainability in water.

In these regions, water is too valuable a resource to be used just once before being returned to Nature. For health reasons, water recycling technologies must be operated with care and a high degree of professionalism. Wastewater recycling is a win-win strategy since it increases the supply of water while reducing the pollution discharged into the environment.

3 examples of wastewater recycling are described:

- Windhoek (Namibia): direct water reclamation for potable use;
- Adelaide (Australia): wastewater recycling and aquifer recharge;
- Honolulu, Hawaii: wastewater recycling in industry.

But several challenges have to be faced to develop this promising solution and achieve sustainability in water: a psychological reluctance for treated wastewater to be accepted; energy consumption reduction; a competition from undervalued conventional water resources.

**Key words:** wastewater, recycling, sustainability, water resource, water scarcity, the price of water, water self-sufficiency, aquifer recharge, membrane technology, energy consumption

Nature is rich in water and for thousands of years mankind has been living without paying much attention to it, except in arid zones, or in regions devastated by flooding. But today, water resources appear to be dwindling. We are seeing a resurgence of the problems of quantity that we thought had been solved. Imbalances between availability and demand, groundwater mining, quality degradation, interregional competition, all bring water issues to the fore.

In this context, recycling wastewater is more and more used. It seems to be a promising solution to achieve sustainability in water. I'd like to describe the challenges, the assets and shortcomings of recycled wastewater, by telling you about the experiences of Veolia Water, the world's leading operator of water and wastewater services.

## I - New resources to deal with new scarcities

The idea of scarcity underwent a sea change in the XXth century: new scarcities appeared while old ones disappeared. But the new shortages call for the invention of new resources. Just as things that we once thought abundant have become scarce, what we considered waste has been transformed into a resource. Wastewater, that so-called "*hostile water*," is now deemed to be useful.

- ***Water is too valuable a resource to be used just once before being returned to Nature.***

Alternative resources provide room to rethink water management in regions stricken by hydric stress. Wastewater recycling is a tried-and-tested solution for producing water suitable for industrial, agricultural and even domestic use.

Where there is too little water, the solution lies not so much in '*sharing scarcity*', but in resorting to alternative resources. The local closing of the water cycle, which creates numerous urban mini-cycles, avoids the premature returning of water to Nature after a single use.

This process applies the principles of industrial ecology to a continuous and open cycle, the water cycle. This enormous, artificially-created short circuit in the water cycle performs the purification work that is carried out by nature over a long route which goes from rivers to the sea, then from the sea to the clouds before falling to earth.

What is more, it reduces discharges of purified wastewater into the natural environment. Wastewater recycling is a win-win strategy since it increases the supply of water while reducing the pollution discharged into the environment. In so doing, it contributes to breaking the too frequently observed link between urban growth and the pollution of aquatic environments.

In the world, 165 billion m<sup>3</sup> of wastewater are collected and treated, but only 2 % are reused. Recycling wastewater is undoubtedly a promising approach, capable of supplying large quantities of water. All the more so given that wastewater is the only resource that expands along with increasing needs; all the more so given that this resource is located exactly where it is needed. Hardly surprising that the world's installed capacity for recycling it is expected to quadruple in the course of the next decade. It is increasingly viewed as a "*secondary raw material*".

Veolia Water is the world leader for this technologies with regarded to installation capacities. It has designed and operates wastewater reuse facilities with a total capacity over 2.5 million m<sup>3</sup> per day.

- ***Wastewater recycling, a tool to face growing water scarcity in a context climate change***

Many arid regions are hostages to hydrology. With climate changes brewing, this dependence risks to become greater.

Wastewater reuse can help local authorities to face some of the consequences of climate changes, I mean the growing scarcity of water in some regions of the world. It can help them not to live beyond their hydrologic means.

“*Security through diversity*” is the motto for Sydney, capital of a country facing its eighth consecutive year of drought. Its recycling wastewater program and its seawater desalination program aim to build a water supply system that is independent of erratic rainfall.

- ***Wastewater recycling allows us to increase water productivity.***

Living in a world of scarce resources means that we have a moral obligation to use each cubic meter of water as efficiently as possible. Recycling wastewater is one way to increase water productivity. By unlinking uses from withdrawals, it maximizes the number of uses of a given quantity of initial resource. By adding one or several extra cycles of use before the water is finally discharged to the natural environment, it extends the water cycle and maximizes the number of uses per m<sup>3</sup> abstracted.

Similarly, recharging aquifers with conventional water or with recycled wastewater, as is done in Adelaide, Australia—a city in the driest state of the driest continent—makes them more productive: it boosts their natural potential.

- ***Wastewater recycling, a step towards water self-sufficiency***

Wastewater recycling enables towns to escape the gloomy arithmetic of water. At a time when a number of nations are rediscovering the benefits of energy self-sufficiency, it is perhaps no bad thing to recall the advantages of water self-sufficiency.

Wastewater recycling, enhances a country’s autonomy as regards its water supply and allows the importing of water from abroad to be reduced or avoided. It reduces the sort of international tensions that can be kindled by a scarcity of resources. It gives access to a secure source of supply, not dependent on unpredictable rainfall, and is located on home territory, and so not subject to international constraints.

### III - 3 examples of wastewater recycling

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- ***Windhoek (Namibia): direct water reclamation for potable use***

Today it is Israel that most uses this technique: three quarters of its wastewater is reused for irrigation. But Windhoek has gone further in terms of the quality of its recycled water. Since 1969, this city has been recycling wastewater on a large scale to directly produce drinking water for its inhabitants.

Namibia has the unenviable privilege of being the driest country in southern Africa. The nearest perennial river is 600 km away from Windhoek, the capital city. Dams are the primary sources of water and there are limited local aquifers availability. Demand is increasing due to the population growth, forecasted annual growth in water consumption in Windhoek is 3%. Average rainfall in the region is 360 mm/yr, average evaporation in the region 3,400 mm/yr.

Regular droughts and continuous shortage of potable water supply has necessitated to invest in large-scale wastewater recycling. Direct water reclamation for potable use has been operating since 1968. It was a world first. Designed to recycle pre-purified wastewater, the plant makes it possible to manage the capital city's chronic water deficit.

In 2001, the city built a new wastewater reclamation plant and called in Veolia Water and its partners to manage it. This new facility which produces 19,000 m<sup>3</sup>/day supplies 250,000 residents. Without this new facility, the city's population will be deprived of 35% of its actual water resource availability.

The water quality is measured according to the WHO Guidelines, to the Rand Water guidelines (South Africa), and to the Water quality Guidelines for Namibia. Water complying with the Rand Water guidelines will have no health implications to a person consuming 2 litres per day of this water over a period of 70 years.

For health reasons, water recycling technologies must be operated with care and a high degree of professionalism. In particular direct reclamation for potable use. To control sanitary risks at Windhoek, the process involves multiple barriers against pathogens: pre-ozonation, coagulation/flocculation, flotation, rapid sand filtering, ozonation, filtering, active carbon adsorption, ultrafiltering, chlorination.

The citizens of Windhoek have over time become used to the idea that potable reuse is included in the water provision process and express a fair amount of pride in the fact that their city in many respects leads the world in direct reclamation. However only in cases where no viable alternative exists will it be possible to consider the introduction of direct potable reclamation.

The Windhoek experience has been a success. The water reclamation scheme has been commonly accepted by the public for 40 years. People were fully informed. *“Living in an arid climate, the Windhoek citizens always fully appreciated and supported the scheme, even with some civic pride”*.

- ***Adelaide (Australia): wastewater recycling and aquifer recharge***

Since January 1996, Veolia Water and its partners have been managing water and wastewater services to 1 million residents of Adelaide. After years of testing by United Water International (a Veolia Water subsidiary), the Commonwealth Scientific and Industrial Research Organization (CSIRO) and the Government of South Australia, aquifer recharge with treated wastewater was begun at the outlet of one of the 4 wastewater treatment plants: the plant of Bolivar plant, with a treatment capacity of 150,000 cubic meters a day.

At Bolivar, reclamation facilities can treat 43,000 m<sup>3</sup> per day. Wastewater reuse and aquifer recharge provide water:

- in the winter, to gradually return the aquifer to its initial piezometric level and store water in it; the stored water is pumped in summer to satisfy part of the horticultural needs;
- in the summer, to irrigate horticultural operations in the Adelaide region.

To comply with the health standards set by the Health Commission of the Environment Protection Agency of South Australia, the treated wastewater undergoes additional treatment at the plant outlet (dissolved air flotation followed by filtration). Then the water goes directly to the fields to be irrigated in the summer, or reinjected into the aquifer in the winter.

The results are:

- an aquifer regularly replenished so that its capacities are maintained or gradually restored. Recharge halt subsidence;
- a groundwater stock to face the water deficit during the dry season. Recharging an aquifer makes water available at all times, even during droughts, to serve all types of need: drinking water, irrigation and industrial uses;

## *Recycling wastewater, a solution to contribute to sustainability in water*

- no water losses by evaporation because water is stored underground, not in the surface. The aquifer plays the same role as a reservoir except that it is underground. This is particularly important in this warm regions, where nearly 50 % of surface water could be lost through evaporation;
- a lesser dependence of the Murray river to satisfy the water demand;
- a noticeable reduction of the environmental impacts of the Bolivar plant, which is the largest managed by Veolia Water in Adelaide.

Aquifer storage and recovery (ASR) is an emerging technology, accepted in the USA as having a significant role for short and long term storage of drinking water, and in Europe and Australia also for its potential for water treatment. The term aquifer storage and recovery applies to sites where the same well is used for injection and recovery.

The Bolivar Reclaimed Water ASR Research Project has been the first reclaimed water ASR project in Australia. Success at Bolivar suggests further applications as sustainable recovery of potable water from non-potable sources, which may be a robust low-cost solution to water supply problems in arid developing countries.

- ***Honolulu, Hawaii: wastewater recycling in industry***

A US Federal Consent Decree required that Honolulu recycled 37,850 m<sup>3</sup> of its wastewater by 2001. This city entered into a 20 year partnership with Veolia Water North America to design, build, and operate a 45,360 m<sup>3</sup>/d water reclamation facility to comply with this Decree. Its goal was to limit the use of groundwater resources following three years of drought.

A 24 km-long distribution system has been built, in parallel with the new facility. Commissioning of the facilities began in 2000.

Processes generate two qualities of water:

- one is a high-purity water that is sold to the power and petrol-refining companies;
- the other quality is for irrigation of golf courses and landscaping, in order to support the tourism industry.

Using this alternative resource has several advantages:

- for the residents: it saves 45,360 m<sup>3</sup> of drinking water a day. Wastewater re-use for industrial purposes freed up fresh water abstracted in order to allow the planned growth of the community. Unused water can be directed to underserved communities. It enhances water security during drought periods;
- for the city: it creates a long term revenue stream from a levy raised on the production of recycled water, and reduces the city's operating costs;
- for industrial clients, it provides an additional solution for satisfying their needs at a competitive price. Actual price being achieved is lower than potable water;
- for the environment, it provides a better protection in this very popular tourist region. It reduces pollution from the sewage being discharged to the sea in this exotic holiday location and and key tourist resort.

#### IV – Some of the challenges of wastewater recycling

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- ***In many countries, a psychological reluctance will have to be overcome before treated wastewater is accepted.***

And this battle is far from being won:

- in 2006, in Toowoomba, a town in Australia with some 90,000 inhabitants, the local mayor organized a referendum asking people what they thought about using recycled wastewater. Residents rejected the project, despite its having been approved by the health authorities. The ongoing drought will doubtless not leave them much choice in the matter;
- closer to home, I can mention the shocked expressions on the faces of an Arab delegation which had been taken to Normandy, near Mont Saint Michel, in France, to visit market gardens irrigated with recycled wastewater;
- In Windhoek, inhabitants had no choice but to rely on their local resources, making the best possible use of them;
- In France, 90 % of people would accept recycled wastewater for irrigation and watering, according to a CECOP 2006 survey. But the percentage of elected officials in favor of reusing wastewater for domestic non potable use is much lower.

- ***Energy remains an ecological and financial challenge when it comes to using non-conventional resources.***

Energy weighs heavily in the procurement budgets of water and wastewater treatment services. In the water services, it is crucial to control energy use and reduce greenhouse gas emissions; it is crucial to reduce the energy dependence of the services it and move toward a less carbon-based economy.

Membrane technologies open the door to recycled wastewater or seawater mobilization. But they are greedy consumers of energy.

Usually, brackish secondary sewage reuse for indirect potable or direct use by industry consumes more or less half of the most efficient energy consumption of seawater desalination. But it consumes the double of the energy needed to treat bad quality freshwater.

Recycling wastewater uses less energy than desalinating seawater, but the water produced is usually not potable. Even though great progress has been made, it remains essential to make recycling and membrane-based process “*energetically more competitive*”.

- ***Wastewater has to face the competition from undervalued conventional water resources.***

Usually the price for regenerated water is lower than that of conventional water in order to encourage its use. But very few water reuse projects achieve financial sustainability through recovering total costs. A 2005 study carried out on 79 projects on an international scale found that only 12 recovered total costs. What is heavy is the construction cost of a second network, since, usually, the recycled wastewater does not meet the quality standards for human consumption.

The fact that, usually, total costs are not covered by subscriber does not mean that these projects are not justified. But reuse won't develop up to its promising potential without establishing appropriate pricing policies. “*Too often reuse schemes turned out too expensive because of competition from*

*undervalued conventional water resources. It makes the bankability of the water reuse project low”<sup>1</sup>. Therefore, in developed countries, “integrating the full-cost recovery principle is certainly a priority to switch to reclaimed water. Another major aspect is the monetarisation of wastewater reuse benefits”<sup>2</sup>.*

In passing, it is worth emphasizing the need to send a clear price message to users about the real value of water. Although water is only available in a finite quantity, its price does not reflect its scarcity. Angel Gurría, Secretary-General of the OECD, reminded us strongly last year that “*the world needs higher water prices.*” There is widespread underpricing of water. There’s an acknowledged dissymmetry in the way governments measure their financial assets and their natural assets such as water.

Grossly undervalued prices perpetuate the illusion that there’s an abundance of water and that nothing is lost when it is wasted. And it is sure that the undervalued conventional water makes it more complicated to develop alternative water resources such as recycled wastewater.

## To conclude:

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Large recycling plants should not obscure the importance of real water resource conservation. A comprehensive resource policy should also encompass many other components. I would like to highlight one of them: protecting water means firstly saving it so as to limit raw water withdrawals.

Water savings in public networks are often the biggest resource immediately available. The reduction in losses achieved between 2002 and 2007 in our 3 concessions in Tangier, Tetouan and Rabat is equivalent to the consumption of 950,000 inhabitants. 950,000 inhabitants, that’s not nothing! In fact, a good operator of public services should save existing resources and at the same time create new resources.

Wastewater reuse is an efficient tool to provide water for irrigation. However, it will be insufficient unless to save above all on water to irrigate crops. Agriculture is the world’s biggest consumer of water and also wastes the most: it accounts for almost two thirds of water usage. Agricultural production cannot continue to increase at the rate necessary to feed the world’s people unless water is used less extravagantly.

We have entered a world of scarce resources. Rising demand means there will no longer be enough water for us to afford the luxury of using it wastefully. The era of poor water management has to end.

Many countries and cities are living above their water means. They will have to learn how to communicate better with that demanding partner, scarcity. We cannot control the climate, but we can manage water. If man is the enemy number 1 of water, he is also – when he wants to be, and gets himself seriously organized – water’s best friend. And recycling wastewater is one of the ways to rescue the lost friendship with water.

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<sup>1</sup> *Guiding the growth of water reuse, Boudewijn Van De Steene, IWA Yearbook 2007*

<sup>2</sup> *Guiding the growth of water reuse, Boudewijn Van De Steene, IWA Yearbook 2007*