UNCONVENTIONAL SOURCES OF WATER SUPPLY

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Summary

By 2025 an estimated 4 billion people will live in countries with high water stress. Indeed, for large parts of the globe a water crisis already exists, while for others, crises loom in the near future. The picture becomes exacerbated in the light of climate change predictions.

A need for the sustainable use of water resources is now strongly established

internationally. Nonetheless, in many regions of the word associated measures can only postpone the time of crisis. Alternative water resources need to be found, and when conventional alternatives are depleted, the use of “unconventional” resources will have to be intensified. The two most important of these are discussed here: *water reclamation* and *seawater desalination*. Other unconventional sources would include rainfall stimulation, the transport of icebergs and fog harvesting – for which practical and large-scale applications still have to be demonstrated satisfactorily.

Water reclamation - also referred to as water reuse - emerged as a strategic option in water management during the late 1960's. Factors which promoted the emergence of water reclamation are discussed. Other issues covered are the technologies required, health considerations, the range of applications, and the importance of public acceptance.

In1957, Kuwait became the first country to rely on *desalination of seawater* for drinking water supply. Since then there has been a dramatic increase in the number of desalination plants. Desalination technology has become increasingly more efficient and affordable, and seawater desalination can be expected to accelerate even further. Although seawater desalination is virtually confined to distillation technologies and reverse osmosis membrane desalination, other technologies which may find future application, are also discussed. Further issues covered concern the quality of the product water, comparison between distillation processes and reverse osmosis, and dual purpose systems such as the coupling of power generation with water desalination.

1. Introduction

It is estimated that 40% of the world’s population lives in countries which have medium-to-high water stress. By 2025 an estimated 4 billion people, or more than half the world population, will live in countries where more than 40 per cent of renewable resources are withdrawn for human uses - an indicator of high water stress under most conditions. This means that for large parts of the globe, a water crisis already exists, while for others crises loom in the near future.

The largest drivers of water use are population growth and increasing water use per capita. In the 20th century, the world population tripled, but water use for human purposes multiplied six-fold.

The global water sector gradually awoke to the gravity of the water situation in various regions of the world, and since 1990 a series of major international events took place, each of which progressively emphasized problems facing the water sector, and urged the implementation of certain basic approaches in coping with these problems. The most important of these evens were:

The *International Conference on Water and the Environment*, Dublin, Ireland (1992)
The *UN Conference on Environment and Development*, Rio de Janeiro, Brazil (1992)
The *Second World Water Forum*, The Hague, Netherlands (2000)
The *World Summit on Sustainable Development*, Johannesburg, South Africa (2002)
The Third *World Water Forum*, Kyoto Japan (2003)

The major concept which emerged from these events, and became progressively refined, is that of *integrated water resources management*, based on the principles of sustainable use of water resources. Business as usual in water management is not an option for the future. For example, it is estimated that as much as 10 per cent of global annual water consumption come from depleting groundwater resources. As a result, groundwater tables are falling by up to several meters a year, threatening the collapse of agricultural systems which are based on the use of such groundwater. Groundwater, the preferred source of drinking water for most people in the world, is also being polluted, particularly through industrial activities in urban areas and agricultural chemicals and fertilizers in rural areas. Clearly such practices are not sustainable. In many instances vital ecosystems have been destroyed through injudicious surface water abstraction and pollution, or are seriously threatened. This too is not sustainable.

The picture becomes even more serious in the light of climate change predictions. Global temperatures will increase, involving rising sea levels and more frequent droughts and floods. In many regions a rise in sea level will cause the intrusion of sea water into coastal freshwater aquifers, rendering them unusable.

Two important elements of integrated water resources management are water demand management (i.e. "more product or use per drop") and more stringent water pollution control measures. Such measures have already yielded impressive results in certain countries. The fact remains, however, that in many regions of the word, such measures can only postpone the time of crisis. Alternative water resources need to be found, and when conventional alternatives are depleted, the use of "unconventional" resources will have to be intensified. The two most important of these so-called unconventional water resources are discussed here: *water reclamation* and *seawater desalination*. Other unconventional sources would include rainfall stimulation, the transport of icebergs and fog harvesting. The practical and large-scale application of these technologies still has to be demonstrated satisfactorily.

2. Water Reclamation

Water reclamation - also referred to as water reuse - can be defined as the treatment of wastewater to make it reusable. The term *water recycling* is also used, but applies more specifically to internal reuse by industry, where a factory processes its own wastewater for recycling inside the factory.

Water reclamation as dealt with here, refers to the *upgrading and reuse of municipal wastewater* for a wide range of applications. In an urban environment, the use of reclaimed water for a purpose which previously required potable water from a distribution network, obviously increases the quantity of water available for potable use. Even when reclaimed water is used outside urban boundaries (e.g. for agricultural irrigation), it means that the equivalent amount of water need not be drawn from sources which may be used for potable water supply.

Wastewater reuse has actually been practiced for a long time, as far back as the 19th century. However, water reclamation as a strategic option in water management, only emerged as a subject of wide-spread international interest and research during the late

1960s. Before that time, water reuse mostly comprised the unplanned reuse of wastewater (treated or untreated), involving the downstream use of wastewater which had been disposed to he water environment, or irrigation with raw or poorly treated wastewater.

2.1. Factors Promoting Water Reclamation

Various factors contributed towards the emergence of water reclamation as an attractive alternative source of water supply:

- The primary motivation for water reclamation is obviously to supplement water supplies. This is particularly the case where the cost of developing alternative sources of supply, such as the importation of water over long distance, becomes prohibitively expensive.
- The disposal standards for wastewater are becoming increasingly stringent, due to health and environmental considerations. This increases the cost of wastewater treatment, which favours the economic feasibility of water reclamation. Nevertheless, it is a common misconception in the planning for water reclamation and reuse, to assume that reclaimed water is necessarily a cheap source of new water. Generally, this assumption is only true when water reclamation facilities are conveniently located near large agricultural or industrial users, and when no additional treatment is required beyond the existing water pollution control facilities from which reclaimed water is delivered.
- Technology for the treatment of wastewater has steadily improved, which facilitated the production of reclaimed water for a wide range of applications.
- Reclaimed water is produced “right at the doorstep” in the urban water environment and is a reliable source, even during droughts.
- Water reuse can also contribute towards the alleviation of water pollution. The direct use of treated wastewater routes this water (which in most cases still contain residual pollutants) away from the natural water environment.
- In coastal areas the marine disposal of effluents is becoming increasingly unacceptable and this practice is to an increasing extent being prohibited by regulating authorities
- Wastewater is considered as a nutrient-rich source that can beneficially be used in agriculture for crop production, with reduced use of fertilizers.
- The implementation of water reclamation can delay or eliminate the expansion of potable water supply and treatment facilities.

The accelerated interest in water reclamation not only induced the rapid implementation of water reuse projects in many parts of the world, but it also lead to the development of specific water reuse policies and guidelines. These, in turn, catalyze further water reclamation initiatives.

In 1970 the California State Water Code stated that “it is the intention of the Legislature that the State undertake all possible steps to encourage development of water reclamation facilities so that reclaimed water is available to help meet the growing water requirements of the State.”

A European Communities Commission Directive (1991) declared that "treated wastewater shall be reused whenever appropriate. Disposal routes shall minimize the adverse effects on the environment"

2.2. Direct and Indirect Reuse

Water reuse can take place either directly or indirectly. *Direct reuse* occurs when wastewater, following treatment, is transported directly to a point of application, or to a dedicated storage facility (excluding groundwater recharge), whence it can be piped to a point of application at a later stage. Direct reuse typically provides water for agricultural and landscape irrigation, industrial applications, and dual water distribution systems.

Indirect reuse can take place in two ways: (1) The discharge of *treated* wastewater to water courses and impoundments, and subsequent withdrawal for further treatment and use, and (2) groundwater recharge with *treated* wastewater and subsequent abstraction of groundwater some distance from the point of recharge.

Indirect reuse can either be *planned* or *unplanned*. *Planned indirect reuse* is a purposeful strategy which takes full cognizance of environmental impacts, and of quantitative and quality considerations. In South Africa, for example, the discharge of treated effluents into water courses is factored into calculations involving the national water balance. The Occoquan Sewage Authority, in the USA, discharge treated effluent into the Occoquan reservoir which is a critical source of drinking water for about 1 million people in Northern Virginia. No negative health effects attributable to this practice have been reported. Groundwater recharge has become a well-established strategy for planned indirect reuse. The aims of groundwater recharge are not confined to the supplementation of water supplies *per se*, but also include the prevention of seawater intrusion into coastal aquifers (this application will be further discussed in Section 2.5.2).

Unplanned or incidental indirect reuse occurs whenever wastewater is discharged to the water environment as a means of disposal. Subsequent reuse is not deliberately intended and is simply a by-product of wastewater disposal practice. Unplanned reuse has been practiced since humankind first commenced the disposal of wastewater to the water environment. Communities located "downstream" have a long history of producing potable water from sources that have often seen multiple cycles of withdrawal and use - e.g. New Orleans (Mississippi River), London (Thames River), and cities and towns in the Rhine River Valley

In both direct and indirect reuse, there is a mixing of treated wastewater with naturally occurring water and, therefore, a dilution effect. Some further purification also takes place through the self-purification processes that occur in nature, such as sedimentation, biological degradation, adsorption onto soil particles, filtration effects and sunlight.

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Bibliography and Suggestions for further study

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Biographical Sketch

Dr Odendaal was Executive Director of the South African Water Research Commission (WRC) over the period 1985 - 2000. The WRC is a body charged with the funding and co-ordination of water research in South Africa, addressing the total water cycle. His former professional positions include: Chairman, Institute of Water Pollution Control, Southern African Branch, 1985; President, Water Institute of Southern Africa (WISA), 1990; President of the International Association on Water Quality (IAWQ), 1998-99; Co-President of the International Water Association (IWA), 1999-2001; and Member of the Nominating Committee for the Stockholm Water Prize, 2001- present. He played a leading role in effecting the merger between the IAWQ and the International Water Services Association (IWSA) to establish the IWA in 1999.

He holds Honorary Membership of WISA; the Yugoslav Water Pollution Control Society; and IWA. He is a Member of the International Water Academy.