Industrial wastewater reclamation technology for urban irrigation

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Type of tool: technology for efficient water use, specifically: industrial wastewater treatment for reuse (irrigation) using a modified process technology for local operations, including MBR (membrane bio-reactor) and UV-disinfection
Issue: industry, agriculture
Location: City of Windhoek, Namibia, Africa.

Challenge and objectives

Many cities in Africa (and elsewhere worldwide) suffer from water scarcity. Fresh and clean water resources may be too valuable to be utilised for the irrigation of urban green, parks, small scale agriculture. In most cities, industrial compounds generate wastewater of quantity and quality that is worthwhile purifying to a standard adequate for irrigational reuse. Figure 1 shows some basic information about the City of Windhoek and its very scarce water resources.

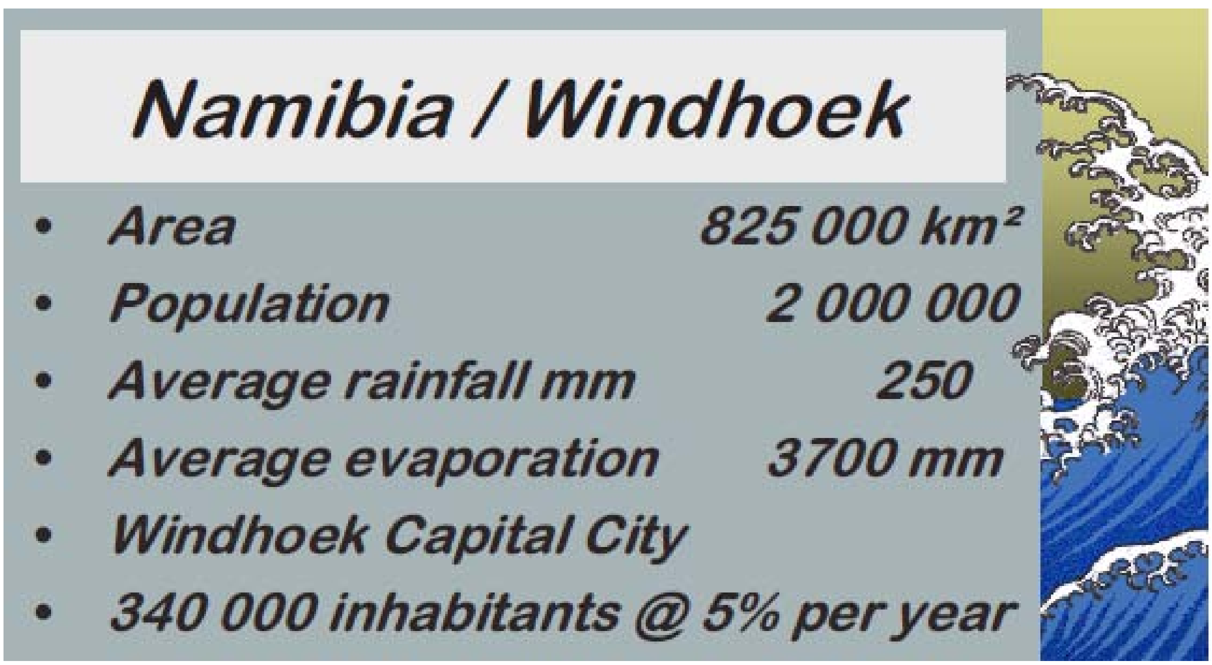

Figure 1. Data of Windhoek City, Namibia

The City of Windhoek is well known for being the first city worldwide to operate a wastewater recycling plant for direct, potable water reuse. The City is already operating a number of reclamation facilities, including for irrigation from domestic wastewaters (see Figure 2). The effort to utilise industrial wastewaters is however new and requires more ambitious treatment technologies exceeding semi-purified irrigation.

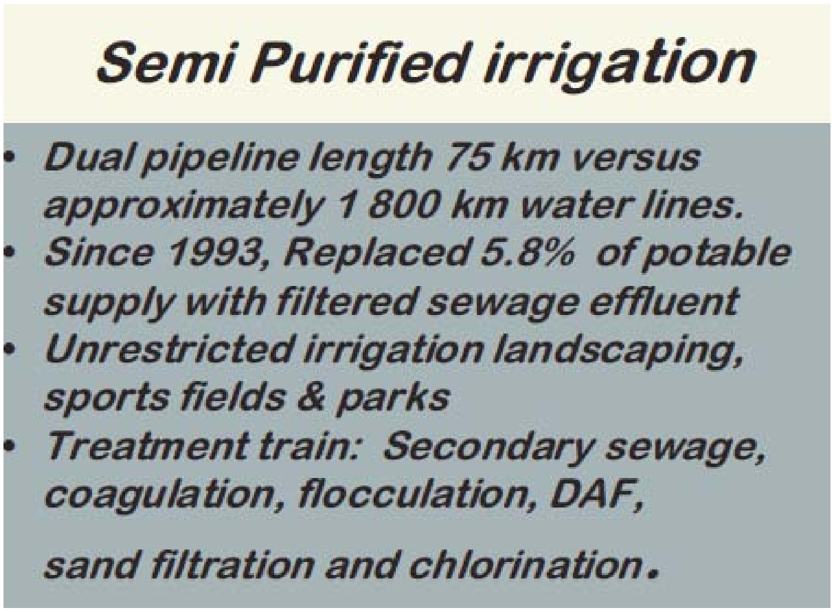

Figure 2. Semi purified irrigation

The objective of the project was to realise a wastewater reclamation plant, based on cost- and energy-efficient technologies, but still viable for local operations. The specific focus was on industrial wastewaters, which may not be suitable for drinking water reclamation, but suitable for irrigational use.

The technical components of the process are conventional mechanical treatment (buffer tank, robust type screening and sand trap), advanced biological treatment (membrane bioreactor, equipped with instrumentation for remote control, automation and easy operations onsite, see Figure 3), compact final settlement tank and post-disinfection through UV (with additional chlorination on request). The standards for wastewater disinfection are quite stringent, not only for crop irrigation, but also for Greenland irrigation (especially for golf courses). To avoid odours, a UV radiation unit for post disinfection of reclaimed wastewater for irrigation was installed (see Figure 4).

Figure 3. The membrane bioreactor with membrane units visible underwater (left), the membrane bioreactor aerated (right)

Figure 4. UV radiation unit for post disinfection of reclaimed wastewater for irrigation

The drivers of technological change

The membrane biological process – adapted to local conditions and with some simplification of the process technology – has made it possible to build a plant of the size and standards under discussion here. Other existing technologies, such as an activated sludge plant with post-treatment (of advanced purification) in a sand filter plus activated carbon etc., would have been too complicated and expensive.

Barriers to technological development, adaptation and adoption

The greatest barrier existing today is the specific cost for purified wastewater, purified up to a standard adequate for safe reuse in irrigation. Compared to the tariffs existing and affordable to be paid through the local industries, it was possible (using all means of cost reduction and efficient financing) to make ends meet.

How were the barriers overcome

The process of implementation was realised through a BOOT-type contract (build, own, operate and transfer), with a contractors consortium consisting of companies located in Africa and companies from Europe. A similar technology (operated on site by the same contractors) had already been proven to be viable for wastewater reuse, with non-industrial wastewater sources (easier treatment) and direct reuse for potable purposes [note: Windhoek was one of the first cities worldwide to realise direct wastewater recycling for supply water].

Lessons learnt from implementation

Without the cooperation of professional technology providers from the private sector and a very proactive public utility, both focusing on greentech business development in their local water sector, the scheme could not have been realised. Technological progress, as well as BOOT and good municipal governance and national finance, were all essential to the successful implementation of this greentech project.

Significant governance changes and institutional development in the local water sector are induced wherever wastewater is regarded as valuable resource, treated with care and reused instead of simply discharged to a sensitive environment.

Scaling up and relevance for developing and transition countries

Scaling up of this project is expected, once project success can be demonstrated and once water tariffs and wastewater charges are reflecting a reasonable portion of real costs (whereas scale-up would be difficult wherever water and wastewater are free of charge, and represent no or little value to the consumers and decision-makers).

Figure 5. Industrial wastewater reclamation technology

Evaluation: economic, environmental and social benefits

Economic benefits

Economic benefits of the project relate to increased land value. Whereas dry land with no water resources available for irrigation is worth little in the project area, irrigated land has quite a high value. This higher value is reflects the economic potential related to land use – from luxury purposes like a golf course down to small agriculture or green land parks. These land use activities will generate new jobs and business opportunities.

Figure 6. Economic opportunities stemming from water reuse for irrigation

Calculating (1) a rise in land value from 2,500 to 20,000 EUR per ha, once irrigational water is available, and after converting bare land to a golf course or high-yield crop land, and expecting (2) that 3,000 m³ of irrigational water is required for each ha per year (with the UJAMS plant producing estimated mio 1,5 m³/a, sufficient for 500 ha), the direct economic value generated through the water reclamation plant is about 17,500 EUR per ha, which is mio 8.75 EUR.

The macro-economic multiplier (reflecting the jobs and incomes generated by the local business developed on the irrigated land, within the economic cycle of salaries spent generating income and salaries for third parties, fourth parties and so on) may be estimated at 2.3 (taking into account what extensive cost-benefit analyses have shown for similar infrastructural investments and operational outcomes), and the macro-economic capital value generated would be 2.3 times higher than mio 8.75 EUR and make as much as mio 20 EUR.

This economic perspective justifies the expenses for the wastewater reclamation plant, which will need an investment of about mio 8 EUR, and total costs of around 3 EUR per m³ (OPEX plus CAPEX under the BOOT contract).

Environmental benefits

Water reuse, in general, results in huge benefits for the environment. The reduction of fresh water intake and the elimination of contaminated wastewater discharge prevent negative environmental impacts.

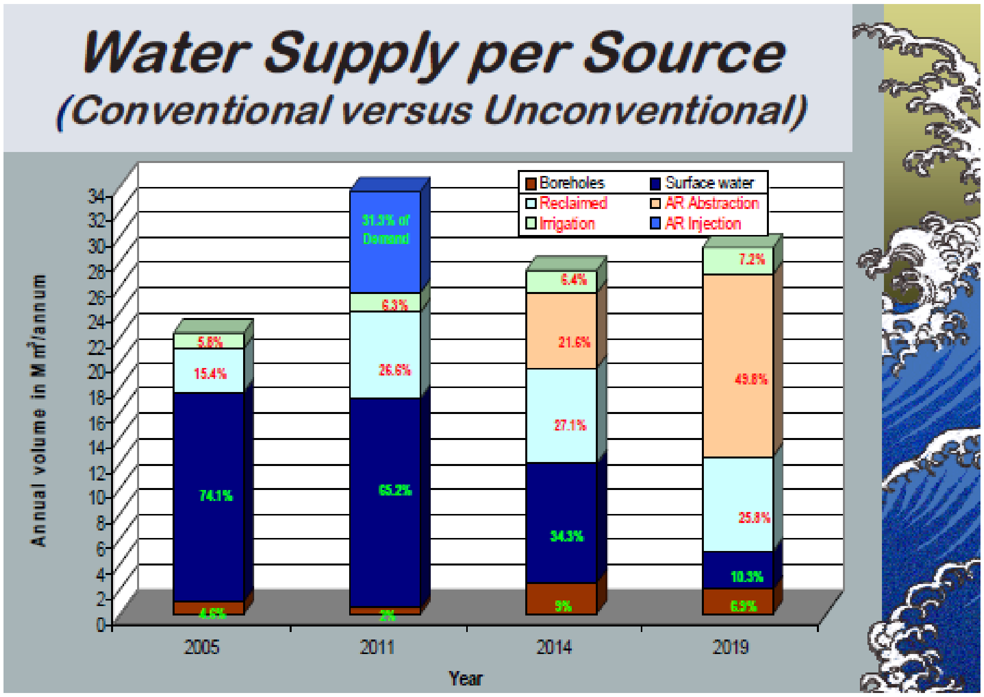

Figure 7. Water supply per source

Social benefits

The project does not directly target low income settlements or poverty alleviation. However, it will generate a considerable social benefit due to the increased availability of land for use after reuse water is available for irrigation. This land will generate business activities, contributing to the economic development of the City of Windhoek, and generating revenues which will serve the public budgets, including those for social welfare.

Furthermore, contamination of the receiving river will be eliminated after the reuse plant comes into operation. This will decrease pollution of the drinking water (raw water) of poor populations downstream who are forced to rely on this source (as they have no other source, or cannot afford water from public stand pipes or elsewhere).