SIMPLICITY – The key to sanitation sustainability

South Africa will have to look beyond conventional wastewater technology if it is to solve its current wastewater treatment crisis, writes Rhodes University PhD scholar Prudence Mambo.

There is universal acknowledgement of the need to accelerate sanitation service delivery, especially in developing countries. According to the World Health Organisation (WHO), 115 people every hour succumb to preventable illnesses aggravated by poor sanitation, hygiene and water contamination.

At the dawn of democratisation in South Africa in 1994, an estimated 21-million South Africans were without basic sanitation. To eliminate this exigency Government introduced the Water Supply and Sanitation White Paper. However, hindrances attributed primarily to poverty, underemployment and high operational costs incurred by bulk water supply and sanitation schemes ensured the previously marginalised poor were unable to pay service delivery charges.

Governmental efforts, primarily the commissioning of 2 410 water and sanitation projects by the Department of Water Affairs and Forestry (DWAF) culminating in an audit by the Council for Scientific and Industrial Research (CSIR) in 2007, revealed that approximately 60% were incomplete or not operational.

The aforementioned concerns thus served as primary drivers for the National Waste Management Strategy (NWMS) of the *Waste Act* (2008) of South Africa, which in summary mandates minimising pollution, environmental degradation and the consumption of natural resources in an effort to conserve access for future generations. It further mandates implementing waste hierarchy, balancing the need for ecologically sustainable development with economic and social development, while promoting universal and affordable waste services (Republic of South Africa, *Waste Act* 2008).

Wastewater is environmentally detrimental due to its nutrient rich, copious nature and frequency of generation. This causes the proliferation of detrimental conditions, such as the explosion of microorganism and plant populations, to the detriment of endemic flora and fauna. Microorganisms in domestic wastewater are enteric and generally disease causing. Thus it is in the interest of governments to implement sustainable solutions for the remediation of wastewater.

At present, more than 80% of South Africa's wastewater treatment works are in disrepair, underperform or are overloaded. Further, South Africa has experienced the deployment of ill-advised, energy/cost/expertise expensive, 'advanced' technology choices that have proven unsustainable in the long term.

The reality is that technologies like reverse osmosis and desalination schemes are better suited to the developed world where the capital resources, infrastructure and expertise are pre-established. Thus, employment of foreign technologies ensures employment of foreign expertise for construction, operation, maintenance and eventual training, while the implementation of simple indigenous technologies ensures the employment creation and up-skilling of the immediate community where the system is deployed.

Integration of pre-existing knowledge and technology awareness will ensure system adoption and that the communities take ownership of their sanitation management resulting in improved, cost-effective, relatable and consistent service delivery as the communities become self-accountable.

Rapid implementation of robust, easy-to-deploy and operate wastewater treatment technologies is urgently required. Furthermore, climate change together with reduced water availability has major food security implications for South Africa, its neighbours and other arid, water-poor countries.

These factors pose profound management implications for both government and business. Correct implementation and management of Integrated Algae Pond Systems (IAPS) optimised for South African conditions can produce clean water for recycle and reuse, provide energy, and generate a biomass suitable for valorisation. Even so, and as with any near market-ready technology, there is an element of risk and/or failure to comply.

Conceptualised by the late Prof Bill Oswald of the University of California in Berkeley, a staunch advocate of sustainable development and access to sanitation for all, the IAPS streamlines conventional wastewater treatment technologies to essentially remediate wastewater biologically.

He combined the primary facultative pond with an in-pond anaerobic digester and enhanced the efficiency of waste stabilisation, facultative and maturation ponds by introducing a raceway with a paddle wheel to evenly mix and polish wastewater while reducing the usual retention time within ponds. This resulted in reduced retention times throughout the system in comparison to other conventional treatment technologies, while the construction of the an in-pond digester underground ensured the temperature required by anaerobic micro-organisms remained constant regardless of the influent temperature. This ensured the global applicability of the technology.

THE BENEFITS OF IAPS

This technology can be implemented where a wastewater treatment system is most needed. It can be operated and maintained by the community in which it is deployed as minimal skill is required for system operation and maintenance. The system can further and most importantly be retrofitted to support pre-existing overburdened and under-performing technologies improving their efficiency and reliability.

Land is not limiting in South Africa and in most parts of Africa thus this technology can easily be implemented and sustainably deployed. The technology can further be retrofitted to suit the type and quantity of wastewater requiring remediation. With simple amendments to the components of the system, it can easily generate methane gas for heating and cooking and, when passed through a generator, generate electricity.

Thus, this system can operate off the electrical grid, while generating an effluent stream suitable for irrigation in agriculture and cattle rearing. The algae biomass, generated in copious amounts can serve as a bio-fertilizer, a substrate for the anaerobic digester and further is responsible for carbon sequestration, which mitigates carbon dioxide emissions into the environment.

The IAPS also has the potential to decrease the costs involved in capturing more water and alleviating the demand on already strained and untapped environmental water reserves. It further reduces the costs involved in treating more water, most notably in terms of the energy required to harvest the water and to divert it to where it is most required.

THE CONSTRAINTS OF IAPS AS DEPLOYED AT THE BELMONT VALLEY WASTEWATER TREATMENT PLANT

The IAPS at the Belmont Valley wastewater treatment plant was constructed to supplement the remediation capability of the of the trickling filter system deployed by the municipality. Thus, there is a pump that diverts 10% of the incumbent wastewater from the plant into the IAPS. Therefore when the pump is not operational, there is no influent into the IAPS until the pump is running.

The IAPS was designed to remediate wastewater to a secondary level, which has in the past not been emphasised. Thus the IAPS at the Belmont valley wastewater treatment plant does not disinfect to a level compliant with the standards set forth by the Department of Water Affairs (DWA) for discharge into the environment primarily due to the lack of a tertiary treatment component, which should not imply that that the IAPS cannot be designed to generate a specific effluent quality.

Rather, with the addition of a tertiary treatment unit and supplementary UV disinfection/chlorination/flocculation, the effluent from the system can be utilised for domestic purposes like flushing toilets, lawn irrigation, washing cars, showers and in the case of agriculture, irrigation.

Another shortcoming of the present configuration is that the anaerobic digester was not designed for methane harvesting. Had the system been configured to harvest methane, the wastewater treatment plant would be operating off the grid and would concomitantly be better equipped to place itself as a sustainable self-sufficient technology. However future designs could easily amend this shortcoming ensuring that even urban and rural communities would have constant, renewable, reliable and carbon neutral electricity generation as sources of energy like wood and fossil fuels are environmentally and health detrimental.

The current paddlewheel design deployed at the Belmont Valley wastewater treatment plant often disconnects from the shaft resulting in impaired wastewater remediation. This has implications for the quality of water effluent discharged from the IAPS. In actuality at times no effluent is discharged from the system due to a lack of sufficient propulsion from a functional paddlewheel as a result the water in the raceway may stagnate.

Another concern is that the paddlewheel utilises electricity to turn, it would be preferable if it either utilised solar energy or methane gas captured from the in-pond anaerobic digester as once there is a power cut both paddlewheels are not operational resulting in an effluent stream that is partially remediated and not suitable for environmental discharge.

Of greatest concern is that the current raceway design is flawed in that only 50% of the final effluent is remediated. This should have been amended by either doubling the size of the second raceway or adding a third raceway to increase the retention time in the system, which currently results in the final effluent not being suitable for environmental discharge.

The world is edging closer to a scenario where water will have to be recycled and more efficiently utilised in order for sustainable and adequate access for all, most especially as water is a right and not a privilege. Education is vital to ensure that water utilisation and remediation costs are reduced to ensure an adequate supply for all.

Sustainable remediation of wastewater is imperative in a drought prone, water stressed country like South Africa. Technologies like the IAPS carefully considered these ever pertinent needs and comprehensively addressed them by generating a treated water, energy and a biomass suitable for agricultural applications, resulting in a system which can be tailored to suit the regions and the needs of the community where it is deployed, ensuring access to sanitation for all and resulting in reduced preventable sanitation and water contamination related disease incidences.

The system has been shown to be cost-efficient, versatile, deployment ready, sustainable, robust, environmentally safe, sustainable, green and capable of facilitating up-skilling in relatively remote communities. Land is available in South Africa and the climate of conducive for efficient year round remediation. So, why not, this system can serve as the stepping stone for improving the quality of life for all. ❑