Subscription-based electronic and print-media serving the African water management industry **March/April 2016 Vol 36 No 1**

WATER

Sewage & Effluent

Back to the future?

Vetiver grass floating systems present low-cost waste water solutions for cash-strapped municipalities.

PAGE 16

ANNUAL SUBSCRIPTION:
6 print editions + **25** e-mail bulletins
South Africa: **R1 000**
International: **USD115**

ISSN 0257-8700

Vetiver grass grows hydroponically on a reservoir at environmental rehabilitation and erosion control company Hydromulch in Bapsfontein.

Back to the future?

"Roughly four-billion litres of below-standard sewage effluent is being released into South Africa's waterways every day …" Anthony Turton wrote in @Liberty, the policy bulletin of the South African Institute of Race Relations. Yet, despite the system failing, the same procedures are being followed to treat wastewater. *Fiona Ingham* looks at affordable, passive processes as an alternative.

In the 1950s, 1960s and early 1970s, virtually all South African municipalities used passive, biological processes and technology to treat wastewater. They were carbon neutral, needed very little energy to run and were not mechanised.

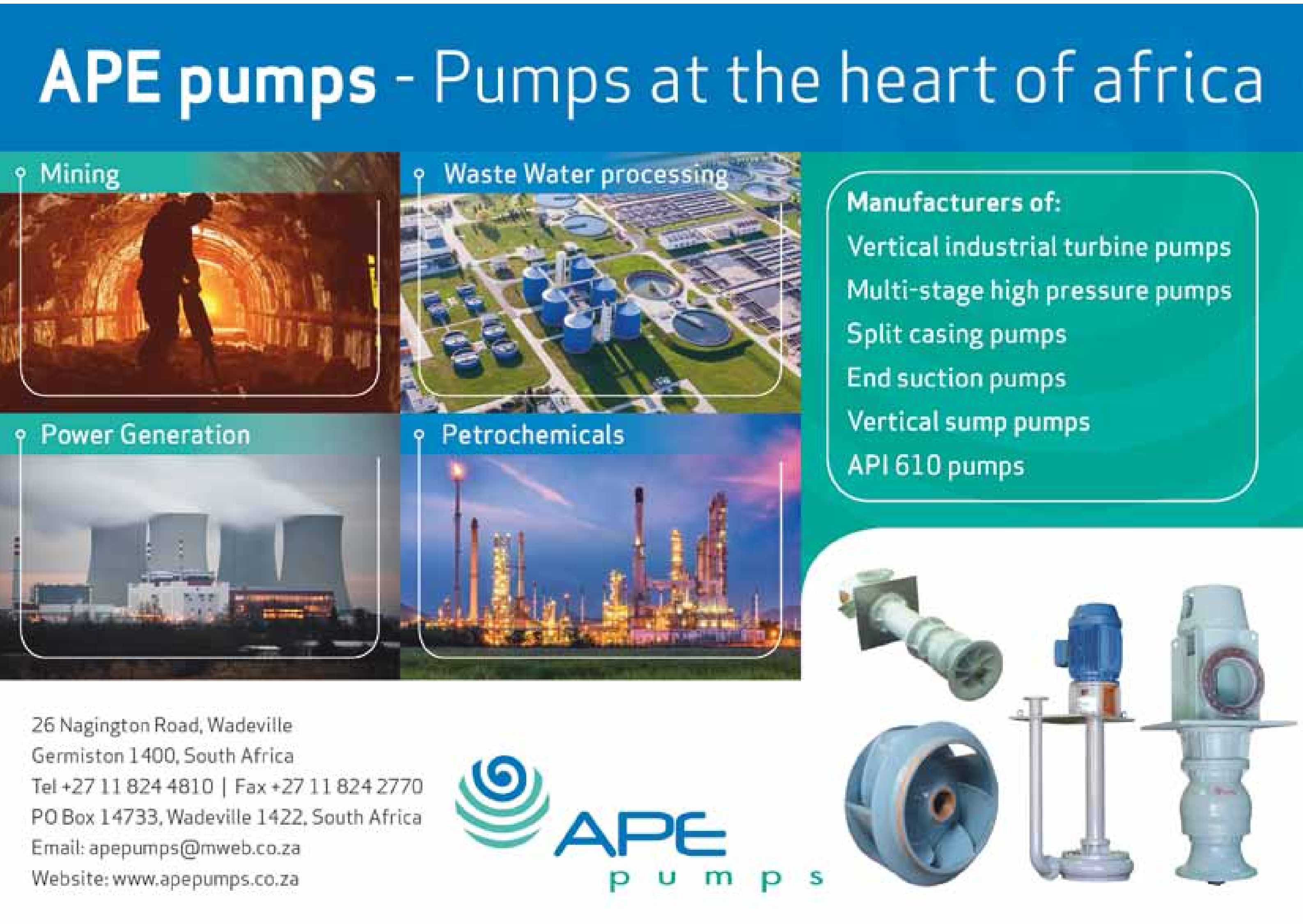
But the tide of progress couldn't be stemmed and this all changed: in the late 1970s and early 1980s mechanised wastewater treatment technology being used overseas was swiftly introduced and refined for South African conditions.

The advantage this presented was that the footprint of these treatment plants became smaller and the nutrient and phosphate removal more efficient. The mechanised system worked well, since it only had to treat the sewage needs of a roughly 22 million people by the 1970s.

"These systems are expensive to maintain and require large operational budgets and a highly qualified staff and management," says Gavin La Trobe, CEO of WSE, a company that focuses on biological, passive, energy neutral, wastewater treatment.

"Instead of constructing a wetland, we float a vetiver wetland on the surface of the polishing pond, where this grass grows hydroponically. Once the system is in, it requires very few inputs and it runs itself."

Bacteria that live in the vetiver grass allow it to absorb high levels of nitrates and phosphates.



"Since the 1980s, the municipalities have had to deal with populations that have grown exponentially, limited water resources and lower income streams. In addition, the available staff has reduced and costs have increased. Municipalities have been left with very difficult mandates, to balance operational requirements with increased service requirement and political prioritisations.

"As a result, many municipalities have had to cut their operational budgets, and cannot afford to employ the teams of engineers, operators and millwrights. So now they have this impressive technology, but without the people in-house to operate and maintain it, and the results are evident. Right now, 80% of our municipal wastewater treatment works are dysfunctional to some extent or another."

Vicious cycle

The public sees traditional passive biological treatment as inferior and antiquated, and they are therefore not considered during new plant selection or upgrades. So, the system that failed before is replaced with similar technology. And so the vicious cycle continues, he says.

"It is not that the technology isn't working – we need to look at the real problems and reasons for such massive contamination and pollution problems. The municipalities need to ask – what can we afford in terms of capital outlay, ability to operate and maintain from both financial and resource perspective?

"Do we have the billions to upgrade? And if it fails? Do we replace again? We have a situation where the technology fails, but is then replaced with more high-tech technology that is even more onerous to maintain," La Trobe says.

"What we at WSE propose is that we go 'back to the future', by using a natural system, and improve the nutrient and phosphate removal with the use of phytoremediation of specially selected plants. This route is seen as primitive, but it isn't. Nature has perfected its processes over millennia, which we know how to package and design. It does not break down and one can pretty much guarantee effluent compliance.

"Decades ago, we had the oxidation ponding system. It worked and continues to work. In places where they are still in operation you don't need much in terms of energy and expertise. We propose that we go back to passive systems. We start with a conventional oxidation ponding system and then add another phase of phytoremediation treatment.

"Instead of constructing a wetland, we float a vetiver wetland on the surface of the polishing pond, where this grass grows hydroponically. Once the system is in, it requires very few inputs and it runs itself."

These polishing ponds with the hydroponic pontoons can be placed downstream of all existing plants as a polishing phase or back-up system. La Trobe explains that there is still a great deal of work for the civil engineering sector, as the wastewater treatment plants need to be adapted to accommodate the additional ponds for this system.

In addition, pontoons can be used on open water bodies such as dam to reduce the nutrient and phosphate build-up within the water body and will reduce the eutrophication of these, resulting in improved water quality and a reduction in the blue-green algae blooms.

Floating hydroponic wetland

Vetiver grass is a perennial grass native to India. It is hardy and non-invasive. With the floating wetland system, the vetiver grasses grow in rows on custom-designed pontoons, with the foliage rising above the water with a prolific, highly dense root system submerged. Vetiver is a plant with one of the highest potential nutrient and phosphate uptakes known: they feed as if they are at the Las Vegas buffet!

The grass is grown for WSE by specialist environmental rehabilitation and erosion control company Hydromulch. "Roley Nöffke, managing director of Hydromulch, is the biggest champion of vetiver in this country," says La Trobe. The Vetiver Network International is a volunteer network that promotes the worldwide use of the vetiver for a sustainable environment, particularly in relation to land and water. "He sits on the Vetiver Network International board of directors."

"Our company was established in 1969," says Hydromulch contracts director Carl Nöffke. "It has for the past 46 years been involved in environmental construction, maintenance and

Vetiver grass roots are lifted to show the long fibrous roots. Wetlands can do for free what engineered systems do at great cost.

Vetiver grass grows in pipes. The grasses have a myriad uses and are also used to prevent soil erosion.

"Most importantly, the vetiver absorbed all the nitrates and all the phosphates. Vetiver is an amazing plant: it also absorbs certain heavy metals. Where you have bacteria like E. Coli, the bacteria attach themselves to the root system, resulting in E. Coli counts of zero. The results were impressive."

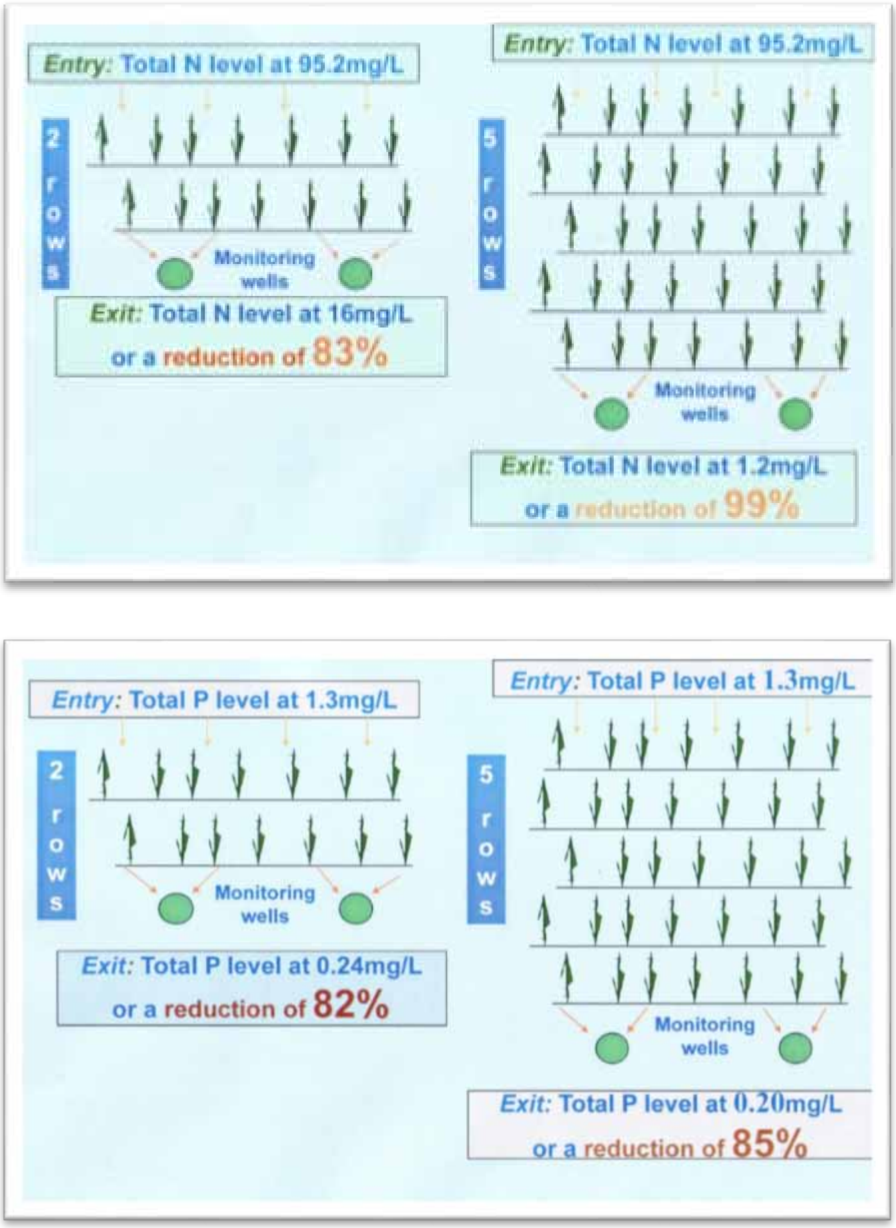


Figure 1: WSE proposal documents

rehabilitation. We also form the construction and developmental arm of WSE," says Carl.

"All the treatment principles remain the same as with the known treatment plants. We have just designed the treatment plants differently to improve the passive treatment process and system, which is able to deal with the issues with the traditional treatment processes.

"The pond sizes have been optimised to minimise the footprint. In addition, with vetiver and its associated byproduct, you can turn sewerage treatment into a sustainable business. Vetiver just loves contaminated water; it loves sewage! It possesses the capability to absorb huge levels of nitrates and phosphates," La Trobe says.

The most pervasive problem with the quality of effluent the world over is the high nutrient loading. When the oxygen levels of the water are reduced, the balance of the water is upset and this results in algae bloom. The presence of blue-green bacteria (cyanobacteria) is potentially hazardous and has already been detected in South Africa's waterways, reports of which have appeared in local media.

Pilot project

La Trobe describes WSE's first pilot project with vetiver grass in 2005 and in 2006. The company renovated an Aids community centre near Lanseria. Conventional onsite treatment could not be used because of the proximity to the Crocodile River, and they needed to put in a closed circuit sanitation system. So they constructed a wetland using vetiver grass, and here the grasses proved their super-absorbent qualities.

"Most importantly, the vetiver absorbed all the nitrates and all the phosphates. Vetiver is an amazing plant: it also absorbs certain heavy metals. Where you have bacteria like E. Coli, the bacteria attach themselves to the root system, resulting in E. Coli counts of zero. The results were impressive.

La Trobe does not advocate that the vetiver grass system is a one-size-fits-all solution nor does he advocate that it replace entire treatment systems. He says that mechanised plants are necessary for large metros, where space is at a premium, and where the budgets are higher. He advocates these systems for small to medium municipalities and rural communities.

"We also advocate that the passive system could be plugged in at the end of any process, as a final polishing stage, which will provide a back-up system to ensure a compliant quality discharge, in the event of a mechanical breakdown."

China and Australia were some of the earliest countries in the world to conduct vetiver research and application in soil erosion and environmental amelioration. Vetiver grass has been applied to agriculture across the globe to reduce run-off and erosion and to stabilise slopes. In the last decade, significant research and numerous projects have demonstrated the success of vetiver used to treat various forms of wastewater, including landfill leachate, domestic sewage, and industrial wastewater.

Many municipalities cannot afford to run their highly mechanised systems, and 80% of municipalities are in this predicament. La Trobe explains that they are not attracting the expertise they need, being engineers and millwrights, nor raise the operational budgets. The money needed to provide adequate mechanical treatment for most of our municipalities' backlog, substantially exceeds the total budget available to them.

"Engineers need to advocate technology that fits our parameters better," he says. "They need to ask what the municipalities can afford. In some instances the required operating budget for the treatment plant accounts for most of the operating budget for the whole municipality, but they insist on additional mechanised plants, because they perceive that this is the only option.

"The highly mechanised wastewater solutions are very good, but the social and economic situation has changed and it's time we re-look our approach to wastewater treatment and implement sustainable solutions," says La Trobe. He puts forward that the municipalities have a host of pressing needs and not all the budget can go on wastewater treatment. No single department has enough money to do what they have to do, despite frequent interventions by national government.

"In any environmental system, there is a tipping point, when the entire system will collapse. The problem of bad quality effluent is not about to happen: it has already happened throughout South Africa. It is only time when we will reach this point in our water systems, The blue-green algae in our water systems are the

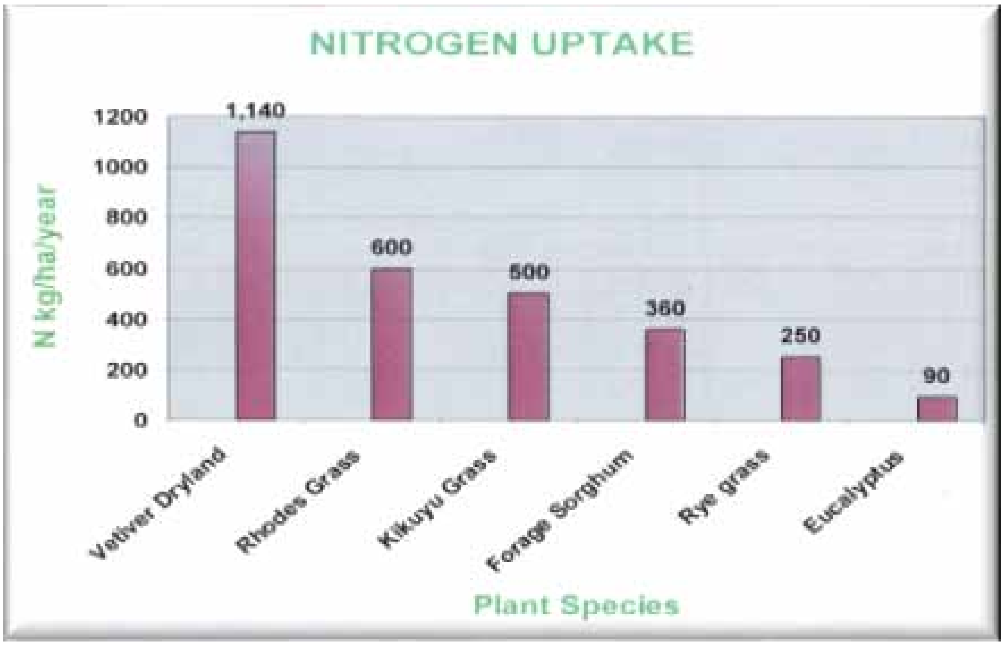


Figure 2. Nitrogen uptake

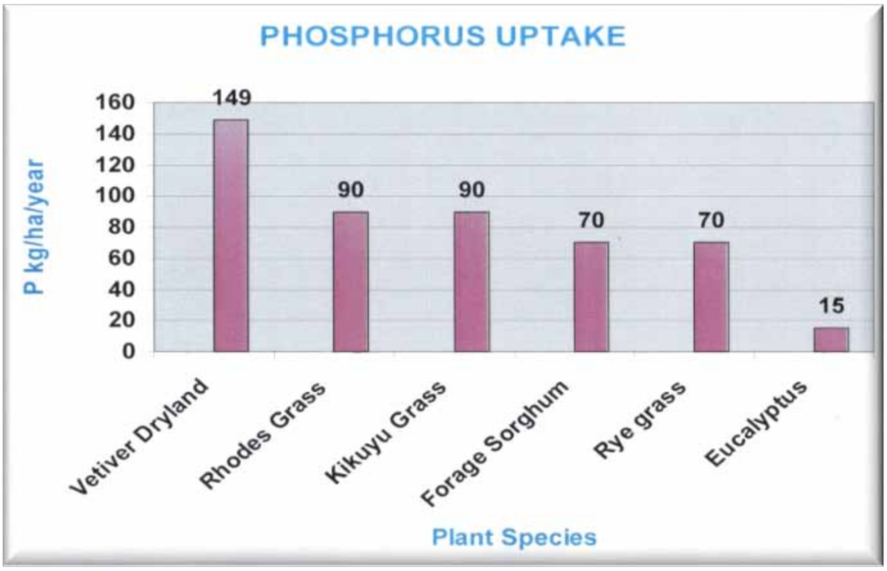
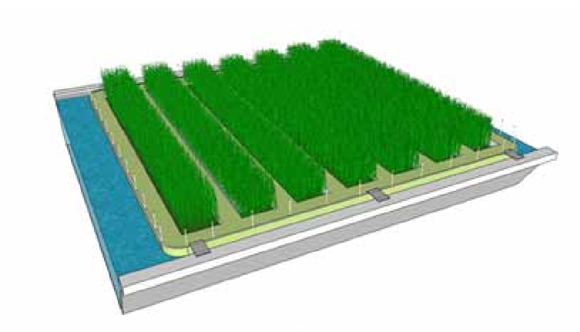


Figure 3. Phosphorus uptake



Patent App Nr: 2011/06740

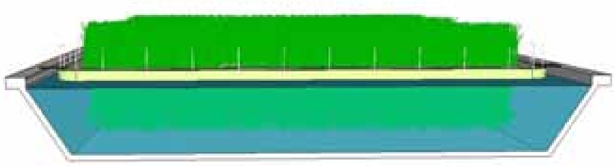


Figure 4. Vetiver floating island wetland

final warning. The processes to treat the eutrophic water to potable levels become significantly more complex and expensive, and if not implemented, could lead to the contamination of the entire potable water network through the country.

"The problem, of course, can be fixed. Anything is possible, with the money and the will. We believe effective passive, low maintenance biological treatment systems and process can play an important role in proving a sustainable solution to this widespread issue.

"We have to go back to basics. We need to look at solutions we can afford. They've been there all along." he says. Although we do not have a full scale treatment system operation in South Africa, a number of municipalities and metros in South Africa are considering the system. Australia has implemented a number of these plants successfully, for up to 500 million litres per day.

"Many wastewater treatment ideas exist and many are good," says Wits academic and previous chairman of the Global Agenda Council on Water Security, Mike Muller. "Artificial wetlands to treat sewage are not new. They are widely practised with urban wastewater. One of the challenges municipal managers face is that there are lots of solutions to fewer problems, so the difficulty is to choose not just the most convincing parties, but the solution that suits that application best."

Water expert at University of Free State Centre for Environmental Management, Prof Anthony Turton agrees that floating systems have a place and offers an example. In a small Karoo town, the bucket system was replaced with water-borne system but the treatment works were not upgraded and the system was quickly overwhelmed. "Here floating islands were suggested as the solution to the problem."

Turton explains that a range of plants, not just vetiver grass, are used to purify water, and each is capable of doing something different. "It is not the plant that does the work, but the bacteria that live in the plant. These bacteria can be genetically modified to do what you want them to do."

"The East Kolkata Wetlands are interesting. They are both constructed and natural wetlands. As the landscape changed and factories were built, the wetlands had to deal with industrial chemicals, and the bacteria mutated as a result. The wetlands have now evolved to a point where mutated bacteria are capable of cleaning up the most complex of toxic molecules and have thus become a biodiversity resource in their own right."

"Wetlands do for free what engineered systems do at great cost," he continues. Turton says that he has conducted initial research on the species of wetland plants that are capable of assimilating different metals and toxins.

"A floating system is a 'quick and dirty' response that can lead to more sophisticated system, such as a vertical flow constructed wetland. Vertical flow constructed wetlands are a relatively new and rapidly evolving technology in the field of ecological and environmental engineering," he says.

Advantages

The vetiver grass system for wastewater treatment is an innovative technology. Its effectiveness has been proven across the globe. It is green, low-carbon, sustainable, low-tech and low-cost and is ideal for cash-strapped municipalities. Beyond the design, installation comprises construction of simple floats or pontoons, and only low-level skills are needed to operate and maintain them. This presents a welcome opportunity to cuts costs and support local workers. Another major attribute is that vetiver grass treatment systems are easily scaled up or down as needed.

Shortcomings

Naturally, the system also has its shortcomings. Most of these disadvantages arise when it is compared to large-scale wastewater treatment applications. Under high flows, the vetiver system requires substantially more space, and this poses a problem in large metropoles. Passive systems require longer retention periods to treat wastewater effectively and special care has to be taken to prevent short-circuiting. Each situation has to be assessed to determine the best approach and design to ensure a long-term sustainable solution.

Possibly the biggest shortcoming of vetiver is that it is simple. Engineers, in particular, are accustomed to a particular image of a mechanised wastewater treatment system, with moving parts. The perception is that if it doesn't look like mechanical treatment plant, it can't be doing the job properly.

Passive systems are static and the work they do is not clearly visible. The system's greatest attribute – simplicity – is also its greatest drawback. Its proponents have a tough job to convince both the public and the government that this a viable wastewater treatment system.