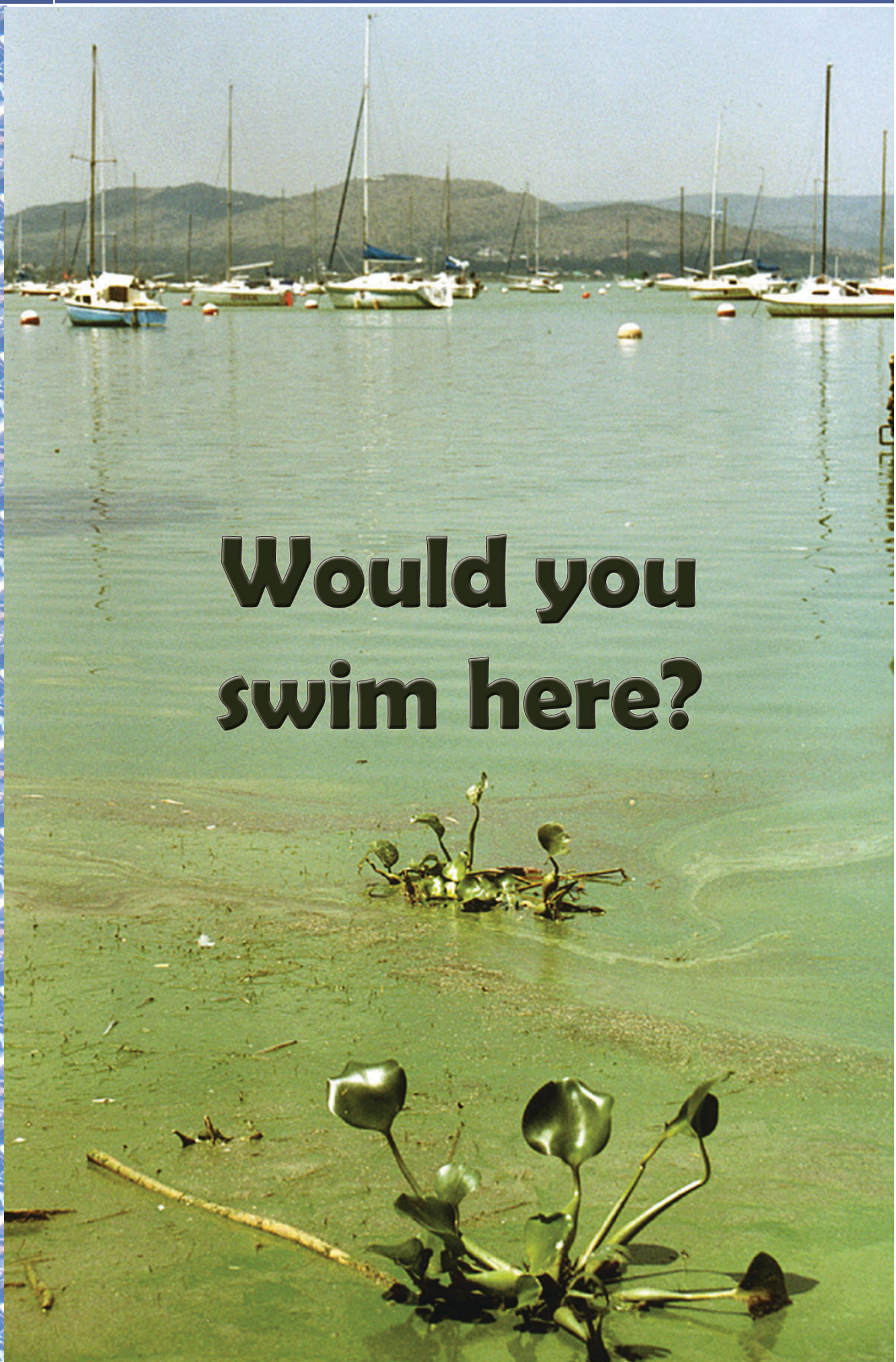

Would you
swim here?

In March this year, Hartbeespoort Dam experienced one of the worst algae blooms in its history. Some three hectares of water close to the dam wall were covered with a 30cm-thick sludge of rotting toxic algae, releasing smelly gases and necessitating an emergency clean-up operation. It was just another episode in the ongoing controversy surrounding what has become one of South Africa's most popular recreational dams and elite country settlements.

By Sophia Dower

Without a doubt, Hartbeespoort Dam has a reputation for being one of the filthiest dams in the world. But does it really deserve all the bad press its getting? Yes and no, says Carin van Ginkel, specialist scientist at the Department of Water Affairs and Forestry (DWAF) in Pretoria.

"More than any other dam in the world, Hartbeespoort suffers from massive seasonal growth of cyanobacteria (previously known as blue-green algae), which accumulates on the dam surface and rots in the sunlight. It releases offensive odours and often looks and smells like raw sewage - but it's not. The sludge is caused by the natural biodegradation of the cyanobacteria, and not human excreta."

Cyanobacterial blooms such as the one in April not only affect the taste and smell of the water supplied to local residents, the foul smell around the dam wall also puts off prospective buyers looking to purchase upmarket homes in the area.

Understandably, it has residents up in arms. Unfortunately, there's no easy solution.

THE ROOT CAUSE

The source of the huge outcry is tiny – a minute cyanobacteria called *Microcystis*, which, through a process known as eutrophication, develops to massive concentrations. Eutrophication is a natural process through which normal nutrient levels in the water are raised, but it is enhanced by human activity in the dam's catchment area. Coupled with other environmental factors such as low rainfall and warm, windless weather, this influx of nutrients leads to rapid and excessive growth of cyanobacteria and aquatic weeds.

Ironically, the cause of the stink is Mother Nature's way of absorbing and removing excess nutrients from the water. However, in attempting to rectify the problem, nature has created another – one that is proving extremely difficult to resolve.

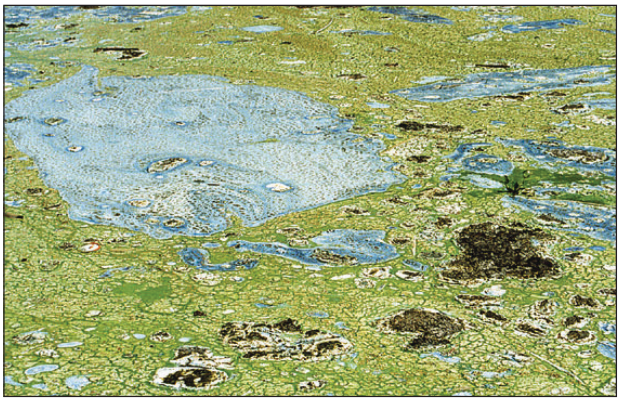
"Hartbeespoort dam is effectively a massive nutrient trap," says van Ginkel. "Approximately 16 sewage works and many industries discharge wastewater effluents from the high density Johannesburg and Pretoria area into the Crocodile River, the main river flowing into the dam. The aridity of South Africa and the historical Water Act enforced companies to discharge all effluent wastewater back into the rivers. All these companies are required to comply with strict water regulations and, since the promulgation of the National Water Act in 1998, are monitored by DWAF to ensure that they do so. Nevertheless, more than half of the water flowing into the dam is phosphorus and nitrogen-rich."

The release of wastewater into catchment areas is widely practised across the world, and is controlled locally by South Africa's new Water Act. So why is it a problem at the Hartbeespoort Dam?

"Much of the nutrients are trapped in the sediments at the bottom of the dam and remain inactive for extended periods," explains van Ginkel. "In summer, however, different thermal layers form in the water column. The deeper layer becomes anaerobic (oxygen depleted). Under these conditions phosphorus is released from the sediments. This process is known as internal loading. When mixed into the upper layers of the water, these nutrients boost algal growth. The cyanobacteria are able to regulate their position in the water column for optimal growth. During a cyanobacterial bloom of *Microcystis* the cyanobacteria form dense accumulations, which then floats to the surface. Once exposed to sunlight, it starts to decompose, and toxins that are normally bound inside the algae, are released."

Van Ginkel adds that the problem is not unique to Hartbeespoort, and occurs in about 20% of South Africa's monitored reservoirs. But for unknown reasons, nowhere else do these "hyperscums" produce so

With water-front properties starting at well over a million Rand apiece, DWAF is under increasing pressure to find a long-term solution to Hartbeespoort's algae problem.



As the cyanobacteria dies, it changes to blue-green and then to black-brown, forming a crust on the surface which looks - and smells - like raw sewage.

A typical cyanobacterial bloom initally looks like pea-green soup. Once it reaches the surface it is blown by wind into smaller inlets, where it accumulates and dies off.

rapidly or in such vast quantities.

"According to a recent DWAF eutrophication survey and prioritisation of monitored dams, Hartbeespoort is not the worst case in terms of its nutrient and algal biomass levels. However, it has relatively clear water that allows more light and heat penetration, which also contribute to algal growth."

SO WHAT'S THE FUSS?

The appearance and smell of the rotting cyanobacteria has led to a number of reports from concerned residents to DWAF that raw sewage is spilling into the dam. This is denied by both DWAF, private consultants and the industries operating in the area.

Petrus Venter, Deputy Regional Director: Water Resource Management of the North West Province, explains that a typical cyanobacterial bloom initially has the appearance of green pea soup. "Cyanobacteria on the surface is blown by wind into smaller inlets where it accumulates and dies off," he says.

"As the cyanobacteria dies it changes from white, to blue-green, and then to black-brown. It then forms a dry crust on the surface which is often mistaken for raw sewage." What happens to the dying bacteria is the same process that applies to a sewage treatment works, namely biological breakdown of organic matter. In this case, however, the organic matter consists of cyanobacterial accumulations.

Another concern voiced by visitors and residents, is the incidence of cholera. But, as Venter explains, there is no relationship between the algal growth and cholera. "The Department tests the dam water every two weeks and so far, no cholera has been detected." Additionally, because the cyanobacteria and phosphorus doesn't penetrate through the sediments, its presence in the dam does not affect local groundwater supplies.

In that case, what's the fuss all about?

"Cyanobacteria can potentially be dangerous to both humans and animals due to their ability to produce toxins. The effect depends on the amount that they ingest or come into contact with," says Venter. "Mostly animals are affected, as they drink the cyanobacteria clumped around the shoreline. The greatest effect on humans is that of the powerful, unpleasant smell. Exposure to the cyanobacteria can also cause gastro-enteritis, skin irritation, nausea and skin lesions. Contact with it is best avoided."

Besides the more obvious inconveniences, the dominance of the cyanobacteria wreaks havoc with the ecosystem in the dam. The decomposition of the cyanobacteria hyperscums depletes oxygen levels, and

(Top) When excess nutrients are released into the water, they boost algae growth. This forms dense accumulations and floats to the surface.

(Left) While cyanobacteria is not unique to Hartbeespoort, nowhere else do these "hyperscums" produce so rapidly or in such vast quantities.

The rotting algae is potentially dangerous to both humans and animals. It also gives off noxious fumes - unfortunately for the Hartbeespoort restaurant outside which this signpost appeared.

– under high temperatures – causes the nitrogen to form ammonia and methane, which can be very toxic to fish and birds. A number of fish and bird kills have been reported at different parts of Hartbeespoort Dam over the years.

TREATMENT OPTIONS

Ironically, the cyanobacteria that's causing all the stink is Mother Nature's way of absorbing and removing excess nutrients from the water. However, in attempting to rectify the unnatural balance of nitrogen and phosphorus, nature is creating a new problem – one that, in this case, is proving extremely difficult to resolve.

Venter explains that a number of treatment and management strategies are used worldwide, although many are not feasible for implementation at Hartbeespoort Dam for cost or practical reasons.

- "Problem" dams can be drained and the sediment dredged. However, draining a major water source is not an option in a country as arid as South Africa.

HARTBEESPOORT – A 30-YEAR-OLD PROBLEM

Originally built for irrigation purposes, the construction of Hartbeespoort Dam served as a job creation scheme to help alleviate the tremendous poverty that prevailed after the First World War. Today Hartbeespoort is the main water supply for some 139 000 households in the Brits and surrounding areas.

When it was filled, the dam was classified as a pristine dam. It was only in the 1970s that cyanobacterial blooms became a problem. The dam's growing popularity as a recreational area, plus the rapid urban developments upstream, soon led to higher nutrient levels in the water – nutrients commonly found in fertilisers, industrial wastewater, sewage effluent and products such as soap and washing powders.

In 1970, the dam was raised by 2,44 m to increase the gross capacity to 205 million m^3. When full, the dam's shoreline is over 56 km long, and the surface area is 2 062 hectares. The dam has a catchment of 4 112 km^2, which is drained by the Crocodile River and its tributaries, the most important of which are the Jukskei, Hennops and Magalies rivers.

Nor does this tackle the root of the problem – nutrient-rich water inflows.

- Dam water can be aerated by feeding air through pipes along the dam floor. This mixes the water and increases oxygen levels, inhibiting cyanobacterial growth. This method has been tested elsewhere in South Africa, but with limited success.
- Chemical additives, such as iron or aluminium sulphate, or copper, prevent the phosphorous from being released or "seeping out" of the sediments. While these additives have no impact on crop irrigation, they could pose a problem for domestic uses.
- The creation of a wetland or pre-impoundment dam could filter nutrients out of the water before it reaches the dam. This is an option that is being considered for the Hartbeespoort Dam.
- Bio-manipulation involves analysing the impoundment's ecosystem and removing any natural elements that somehow contribute to the release of phosphorus from the sediment; or adding elements that absorb the phosphorus or control the cyanobacterial growth. One option is harvesting surplus fish, such as carp, which is a bottom-feeder that disturbs the sediment to such an extent that phosphorus is released from the sediments.
- Physical removal of the cyanobacterial scum is the most successful management option used to date. In April, two private companies were contracted by the department to clear the surface of the rotting biomass. This involved pumping the algae through pipes over the dam wall to a safe dry area on the northern side, where it was treated to mitigate the odours and accelerate the natural decomposition process. The clean-up was coordinated by ENVIROKONSULT, a local private company of environmental scientists, and HAZMAT (Enviroserv) which handled the mechanical removal of the dried cyanobacterial scum.

"In a nutshell, we need to find a long-term solution that suits all the different people who currently benefit from the dam," says Venter. "The users and their varying needs – from irrigation to recreation to domestic use - limit our options. Therefore, they should all play a part in finding the solution."

MAKING PROGRESS

The Hartbeespoort Water Action Group (HWAG) was formed in 2000, comprising members of the Department and the local community. HWAG has been quite active in obtaining funds, both from government and from some of the companies operating close to the dam. This funding has yet to be put to good use.

Venter explains that the Department is working with HWAG to appoint a private consultant to put in place a long-term business plan with sustainable water management and rehabilitation strategies.

"The group has formed a Section 21 company, and will be implementing levies on local industries and residents, which can then be used for problem management." At this stage, however, promises have been more forthcoming than hard cash, and Venter says progress is slow. "Some equipment has been bought with a view to handling fast, effective clean-ups such as the one in April," he says. "But much-needed finance is still outstanding – as is commitment from many of the larger property developers in the area."

To date, however, both the department and local action groups can boast a number of achievements:

- DWAF has instituted measures to limit the discharge of phosphorus into surface water. Specific standards (1 mg/ℓ ortho-phosphorus) were introduced in 1985 and have been managed ever since. Some treatment works already comply with a standard of 0,5 mg/ℓ ortho-phosphorus.
- Dam water and rivers up and downstream are regularly monitored for the presence of pollutants and cholera.
- DWAF has developed, and manages integrated resource and wastewater management plans, and conducts regular general inspections. It also facilitates clean-up actions and preventative measures.
- Residents and visitors to the region participate in projects to eliminate algal growth, such as the skimmer project which traps and removed algae from the water surface with nets.
- Cyanobacterial bulldozing takes place to move solid scum away from the shoreline, and a floating weir has been installed to separate certain parts of the water, to enable a process of phosphorus removal.
- An ultrasonic algae killer has been installed in an experimental project during the year 2000 cyanobacterial bloom in the Leeuspruit section of Hartbeespoort Dam.
- General public awareness and education campaigns have been launched, aimed at residents and visitors.

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