**DR Anthony Turton** holds two professorships: one in the Centre for Environmental Management at the University of Free State and another as part of the UNESCO Chair in Groundwater Management at the University of Western Cape. He is a founding director of the Ecological Engineering Institute of Africa where he is mainstreaming solutions, most notably with the development of an engineered wetland that is being patented. His current work is in the mining sector where he specialises in the development of strategies and technologies to mitigate the risk arising from the uranium contamination of Johannesburg; and acid mine drainage (AMD) as the gold industry reaches the end of its productive life. He has pioneered the concept of Closure Mining that makes a business case for the rehabilitation of mining-impacted landscapes.

As a Trustee of the Water Stewardship Council of Southern Africa he encourages behavioural change through positive inducement. He is co-founder of the South African Water and Energy Forum (SAWEF) that introduced the notion of the Water-Energy-Food Nexus to the public domain. He is the past Vice President of the International Water Resource Association (IWRA) and a past Deputy Governor of the World Water Council. He currently serves as Editor of the international journal "Water Policy" and sits on the editorial boards of various technical journals including "Water International", "Water Alternatives", the "International Journal of Water Governance" and the Springer Verlag textbook series on water resource management. He has recently been appointed to the American Society of Mechanical Engineers as a Contributing Member to the Water and Energy Group Subcommittee on Innovative Water Conservation, Reuse and Recovery Technologies for a term ending in June 2019.

# What Dare not be Spoken about Water

*Statehood in South Africa owes its very existence to natural resources. It was the discovery of diamonds along the Orange River in 1867, and the subsequent discovery of gold in the Transvaal Republic in 1886, that set in motion an unstoppable series of events triggering the Second Anglo-Boer War. The central objective of this war was control over the mineral resources of the region, not yet a country and thus not subject to one sovereign control. This violent process, involving the first use of concentration camps in which more people died of disease and starvation than on the field of battle, culminated in the Act of Union in 1910. Attempting to forge a complex mixture of cultures and identities into one coherent national state, the Act of Union created a legal and institutional framework that had as its core objective, the extraction of resources and the repatriation of the wealth created back to Britain.*

In order to exploit the full economic potential of this new sovereign state called the Union of South Africa, infrastructure was needed. This drove the process of modernization that transformed the largely subsistence 19th century agrarian economy into a 20th century industrial economy. Central to this process was water, because the largest known gold deposit on earth was located in an arid landscape, populated only by migrating herds of wildebeest, zebra and springbok.

Thus began one of the largest man-made manipulations of aquatic ecosystems on the planet. Rand Water Board was created while the ashes of the Boer War were still smouldering. The single task given to this organ was the creation of the hydraulic infrastructure on which the national economy of the South African state could be built. Predating the creation of the state itself, Rand Water Board was initially staffed by military engineers from Britain. The first order of business was securing water for the dusty shanty town that was starting to grow as prospectors, prostitutes and investors converged on the Witwatersrand goldfields. Initial water was secured from natural springs and wells in places like Ellis Park and what is now Johannesburg Hospital. As demand for water grew the massive dolomite systems west of Johannesburg were brought into production by developing the Zuurbekom well fields, still in production today.

*The capture, control, processing and delivery of water became the invisible but vital function that enabled the South African state to be built.*

As gold production grew, so did the demand for water, driving an ever expanding network of pipelines and related hydraulic infrastructure over an increasingly large geographic footprint. Attracted by the possibility of jobs, people came in their droves. This created a new set of challenges as the management of sewage started to manifest as a problem. The more Rand Water Board performed hydraulic miracles by pumping water uphill from the Orange River basin to the growing urban sprawl along the Witwatersrand continental watershed divide, the more sewage flowed downhill into the Limpopo River basin. What Nature had dictated should be the flow of water into the Atlantic Ocean on the west coast, now became streamflow in rivers discharging into the Indian Ocean on the east coast. Rand Water Board spawned similar institutions in the Orange Free State when gold was discovered in the so-called KOSH area (Klerksdorp, Orkney, Stillfontein, Hartebeesfontein), and when the metropolitan areas of Cape Town and Durban grew. The capture, control, processing and delivery of water became the invisible but vital function that enabled the South African state to be built.

Statehood is one thing, but nationhood is a different thing all together. As the modern economy diversified it created a social structure defined by land ownership and the privilege of having safe water on tap. Economic class thus became linked with ownership of, and access to, natural resources. When we became a democracy in 1994 it is logical that this issue should become central to the political process. As we re-engineered the structure of society in a sincere attempt to seek redress and social justice, the management of water again fell under the spotlight. The new national constitution transformed the state from a structure based on four provinces, into a new structure based on nine provinces onto which was superimposed a new progressive architecture of governance. Central to this governance shift was four aspects that have now become relevant to any informed discussion on water in the context of nationhood. These are:

- Stripping of water rights from land ownership as a subtle but powerful instrument of redress.
- Nationalization of water resources under the custodial role of the state.
- Amalgamation of municipal structures designed to rationalize the allocation of resources in the quest for social equity.
- Transformation of all organs of state to reflect the social demographics of the country with the policy of cadre deployment at the heart of this process.

*Northern Cape Province, Orange River to Upington*

South Africa now has 1,085 water treatment systems supplying potable water to the nation. These plants process raw water from the nearest river, producing potable water that is then reticulated into a complex set of pipes, reservoirs and pumping stations. All of these are artefacts from our historic past, so each is embedded in a specific set of circumstances. Some are world class, such as those operated by Rand Water Board and other major water boards like Umgeni Water, but in reality there is a wide range from very small rural systems to extremely large urban systems. Of these 1,085 there are 250 reported to be operating "below standard" according to official reports.

*The total volume of water that flows in South Africa's combined rivers on an annual average is 48 billion cubic metres (BCM). This is the total of every single drop flowing in every river irrespective of where it is located in the country.*

This is only part of the picture however. We also have 824 waste water treatment works (WWTW's), collectively processing 5,128 Ml/d (million litres) of raw sewage. This is an important number so the reader needs to reflect on what it means. We are speaking here of 5,128 million litres per day, or stated differently, 5.12 billion litres of sewage that keeps on flowing in a never-ending flood. Of this amount only 836 Ml/d is processed to a safe level of discharge back into our nation's rivers. This means that the rest – a staggering 4,292 Ml/d or 4.29 billion litres – of partially treated sewage flows directly into our rivers and dams every single day. It is here that the analysis becomes interesting, because South Africa is now facing a new challenge. Official communications from the state are at great pains to announce that there is enough water in South Africa. This is partially true, so let us unpack this information in more detail.

The total volume of water that flows in South Africa's combined rivers on an annual average is 48 billion cubic metres (BCM). This is the total of every single drop flowing in every river irrespective of where it is located in the country. This is called streamflow and is a significant part of our natural resource endowment, so let us delve deeper into this number. If one thinks of rainfall becoming streamflow,

there is a new dimension that the reader needs to grasp. Of 100 units of rain falling over the entire South African surface area during an average year, only 8 units end up in the river. A staggering 92% of all water falling as rainfall is lost before it enters the river. This loss is called evapotranspiration and it consists of two major components: evaporation of water intercepted by the large surface area of leaves; and the transpiration of water lifted from the soil by roots to be transpired via the leaves. This means that our national water constraint is the conversion of rainfall to streamflow, so let us delve a little into this aspect to better understand what we have done in the past to overcome this.

*Gauteng Province is home to around 20% of the national population, and each time someone flushes the toilet, they transfer water from the Orange River basin into the Limpopo River basin. But more importantly, these two river basins only have a 5% conversion of rainfall into streamflow.*

The annual average conversion of rainfall to streamflow is just over 8% at national level. But averages hide nuanced facts. One of these nuanced facts is that our national economic development is not evenly dispersed over the entire country. In fact there are two river basins that stand out above all else by virtue of the economic significance derived from water in those two systems. These two rivers are the Orange that naturally discharges into the Atlantic Ocean in the west, and the Limpopo that naturally discharges into the Indian Ocean in the east. Both of these rivers have their source in the Witwatersrand continental watershed divide, which is also the physical location of the largest single urban conurbation in the world that is unique by virtue of the fact that it is not located on a river, lake or seafront. The stunning success of Rand Water Board over more than a century has created a large city that is now 100% dependent on the perpetual provision of those hydraulic miracles now taken for granted. Gauteng Province is home to around 20% of the national population, and each time someone flushes the toilet, they transfer water from the Orange River basin into the Limpopo River basin. But more importantly, these two river basins only have a 5% conversion of rainfall into streamflow. Simplistically this means that of a 100 units of rainfall that occurs naturally in either of these two river basins, a paltry 5 unit's end up in the river. But it gets more interesting, because if we take the Orange River basin, we have built dams in that system to trap a staggering 193% of the annual average streamflow. Stated differently, if we call the 5 units of water that end up in the river on an annual average 100% of streamflow, then we have built storage capacity for 193 units. In short we have almost twice as much storage capacity in the Orange River basin – our single most important water resource by virtue of its strategic contribution to the national economy – as water that flows through that system during an average year.

## Why is this important?

The significance of our dams is the role they play as strategic storage devices, balancing out the low flows accompanied by naturally-occurring drought, with the high flows associated with the natural rainy season. Stated differently, at national level we have built storage capacity for 38 BCM, which provides the hydraulic foundation of our national economy by virtue of the assurance of supply it enables. More importantly however, the extent of the manipulation of natural systems that has underpinned the performance of the hydraulic miracles, which have given us the economic growth that has occurred in the post Anglo-Boer War era creating

the South African state in the first place, is now manifesting as a major risk. Of the nine provinces in contemporary South Africa, seven of these are dependent for more than 60% of their local economic activity on the transfer of water from other systems, with Gauteng being 100% dependent. Turn the pumps off and overnight Gauteng ceases to function in totality, but so does 60% of the other six provinces.

Few people know about this.

The transfer of water from one river basin to another is an invisible but vital element of our national economic wellbeing. Part of that inter-basin transfer of water is by means of sewage return flows, so the risk associated with the management of sewage plant needs to be understood in more detail. Of the 5.1 billion litres of water that flow daily through our WWTW's, a staggering 4.9 billion litres returns to our rivers and dams in a partially treated condition. When compared to acid mine drainage (AMD) as a point source pollution, the only known case of persistent uncontrolled decant is into the Tweelopies Spruit with an annual average of 18 Ml/d, some 238 times smaller than the daily flow of partially treated sewage (4,292 Ml/d). This makes the state the biggest single polluter of water in the country. Which takes us back to the nation-building aspect of water, where we need to now ask awkward questions about the ability of the state to effectively manage a strategic resource that has now been nationalized, within an architecture of governance that is known to be under severe strain.

*Around 75% of our bulk storage capacity in large dams is known to be contaminated by Cyanobacteria that produce a potent toxin known as Microcystin. Developed countries become concerned at levels of microcystin at 10 ug/l, yet we have persistent levels between 10,000 ug/l and 18,000 ug/l and none of our 1,085 water treatment systems have the technical capacity to remove this toxin from the water.*

The 250 potable water systems we have in place are simply unable to process this highly contaminated water now flowing in our river and dams into safe drinking water, and indications are that even the best performing bulk supplier is being swamped by the increasingly high biological load entering the treatment plants. Around 75% of our bulk storage capacity in large dams is known to be contaminated by Cyanobacteria that produce a potent toxin known as Microcystin. Developed countries become concerned at levels of microcystin at 10 ug/l, yet we have persistent levels between 10,000 ug/l and 18,000 ug/l and none of our 1,085 water treatment systems have the technical capacity to remove this toxin from the water. This means that we are increasingly being exposed to a hazard that is hard to define and difficult to communicate, but also persistently denied by the state. Official government reports downplay the microcystin problem by reporting a mere 5% of the resource as being contaminated. This is possible through an inadequate standard definition supported by a dysfunctional monitoring system and tolerated by an ill-informed public.

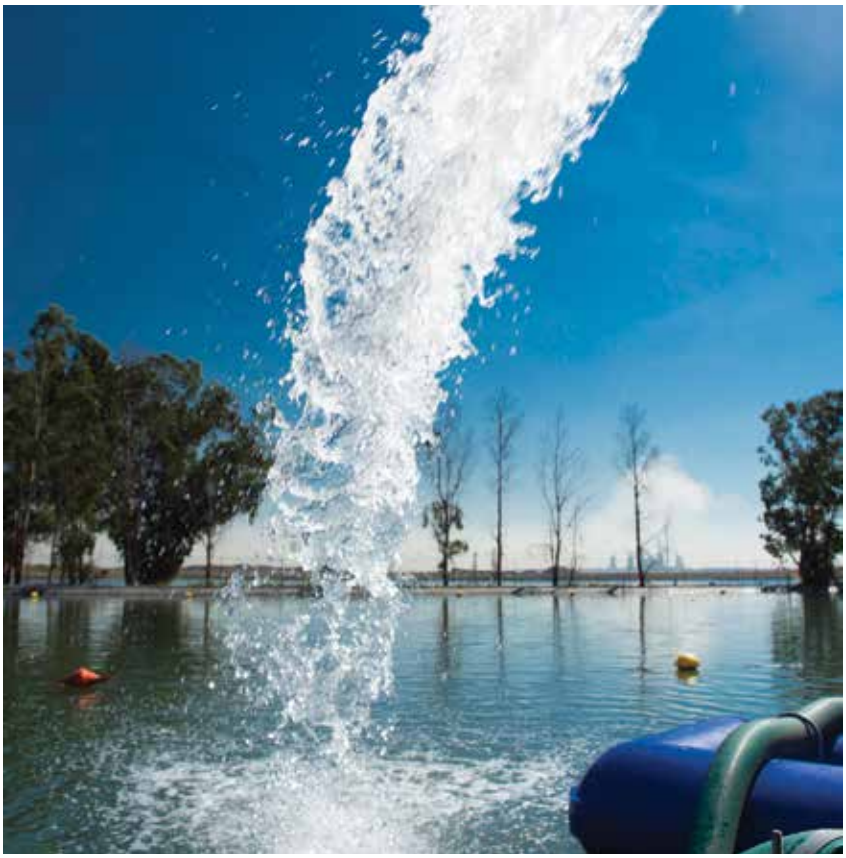
As a young democracy we need to have an informed public. We also need that public to clearly articulate its interests and concerns to political parties that contest elections for the purpose of governing on behalf of their respective constituencies. In order to inform that debate we need the free flow of information. But more importantly we need to enable technical persons that have insight into complex matters of this nature, to speak freely without the risk of retribution by the state when and if they speak of what dare not be mentioned in public.

As we enter the pre-municipal election phase, we need to reflect on the potential of water resource management and governance as a nation-builder. We have the state of South Africa, but we are far from a commonly defined nationhood, so now is the time to dare speak of this matter in the context of water quality. Getting back to the official rhetoric of government that we have enough water in the country, the ugly reality is that it is heavily contaminated by partially treated sewage and a range of other industrial pollutants. It is true that we do not have a volumetric water constraint that the government is at pains to tell us about, but it is also true that the water we now have in our dams is no longer fit for purpose. We have an induced scarcity of water, not a natural scarcity of water. This is our collective problem as a state, so this could become the vehicle through which we start to build a collective identity as a nation. Surely the price of democracy should not be the contamination of our precious water resources with raw sewage, merely because of a failure of the architecture of progressive governance structures?

*If we recycle our existing national water resource 1.6 times by 2030, then we can enjoy economic prosperity without having to transfer water from the Congo River and other distant sources.*

We need a robust national debate about water as the foundation to our national economy and a vehicle for social transformation to a just society in which all citizens can reach their full potential. To help focus that debate this is what we need to do:

- Become aware of the human health risks associated with chronic exposure to Microcystin toxins arising from hypertrophic dams. This needs to be embedded in schools as part of the curriculum, as well as in our national science councils and centres of research and higher learning.
- We need to be assured by the Presidency that full employment and sustained economic growth is dependent on us becoming a recycling economy. If we recycle our existing national water resource 1.6 times by 2030, then we can enjoy economic prosperity without having to transfer water from the Congo River and other distant sources. Only once the Presidency makes this announcement, will all policies be aligned, including science, engineering and technology development needed to manage the transition to a fundamentally water-constrained economy that nobody wants to admit actually exists.
- We need to convert all of our current sewage works into water recovery plant that harvests energy and chemicals as a core business, but also producing clean safe water as a by-product. Central to this is the development of technology to recover chemically pure phosphate, a mineral of growing global scarcity that we are currently giving away for free.
- We need to debate the merits of a dual stream reticulation economy in which water of different qualities and prices is used for different productive purposes. We need to embed this in our national building codes. Just as it does not make sense to flush a toilet with clean drinking water, is also makes good sense to process platinum with industrial grade grey water that has been recovered from contaminated mine water elsewhere.
- Of great importance we need to streamline the process of water use licence applications, because growing evidence suggests that the state is overwhelmed by the complexity of this process. Central to this is the granting of mining rights without regard to the impact on water. The state grants a mineral right through one department, only to have that right sterilized by a different department because of water resource constraints, creating the impression that



we have a dysfunctional state. This is translating into perceptions of risk by current and potential investors, so we need to understand the role played by regulatory compliance in the decision-making process that investors engage in before they invest in the country or a specific industry.

- We need to ask the most awkward question of all – is the time not ripe for service delivery to become a key issue in the forthcoming municipal elections? Is it fair to accept that citizens must be satisfied with sewage contaminated rivers overwhelming water treatment plants with biological loads that they were never designed to deal with? If the price of democracy is the need to be satisfied with faeces in our water, are we not selling ourselves short as a nation?

South Africa is facing a water crisis of unprecedented proportions. But that crisis is different from the form anticipated. It is not about the volume of water we have available, but rather about the architecture of governance and the role of water as a nation-builder. Sadly, those persons working on this topic have either been silenced or intimidated into submission, so there are few credible voices out there capable of injecting ideas into this national debate. The free flow of information is the lifeblood of any functioning democracy, so informed decision-makers need to know the status of sewage management in the country. A recent decision by the Minister of Water and Sanitation has caused the enforcement arm of DWS to selectively apply the law by ignoring the state as the biggest single polluter, eroding the rule of law and entrenching the system of cadre deployment to the detriment of public health. This is simply unacceptable in a functional democracy.