Large dams and the environment:

SA's cooperative history (1945-1980)

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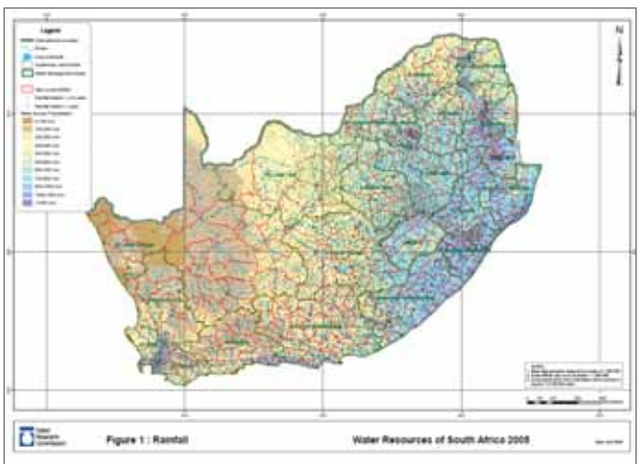
THROUGHOUT THE AGES the lives of people and water have been inextricably linked. On a planet that is mostly covered in water, but where less than 2.5% of it is fresh, the ability of societies to regulate and manipulate the water that is available to them has not only been key to their progress and development, but to their very survival.



A map from the Water Resources 2005 study showing South Africa's annual rainfall; South Africa's low average annual rainfall and its climate variability have historically prompted the construction of dams

To overcome its climatic variability and water scarcity South Africa has historically depended on the construction of large dams to stabilise supply. These dams typically store two to three times the mean annual flow of the rivers in which they are constructed.

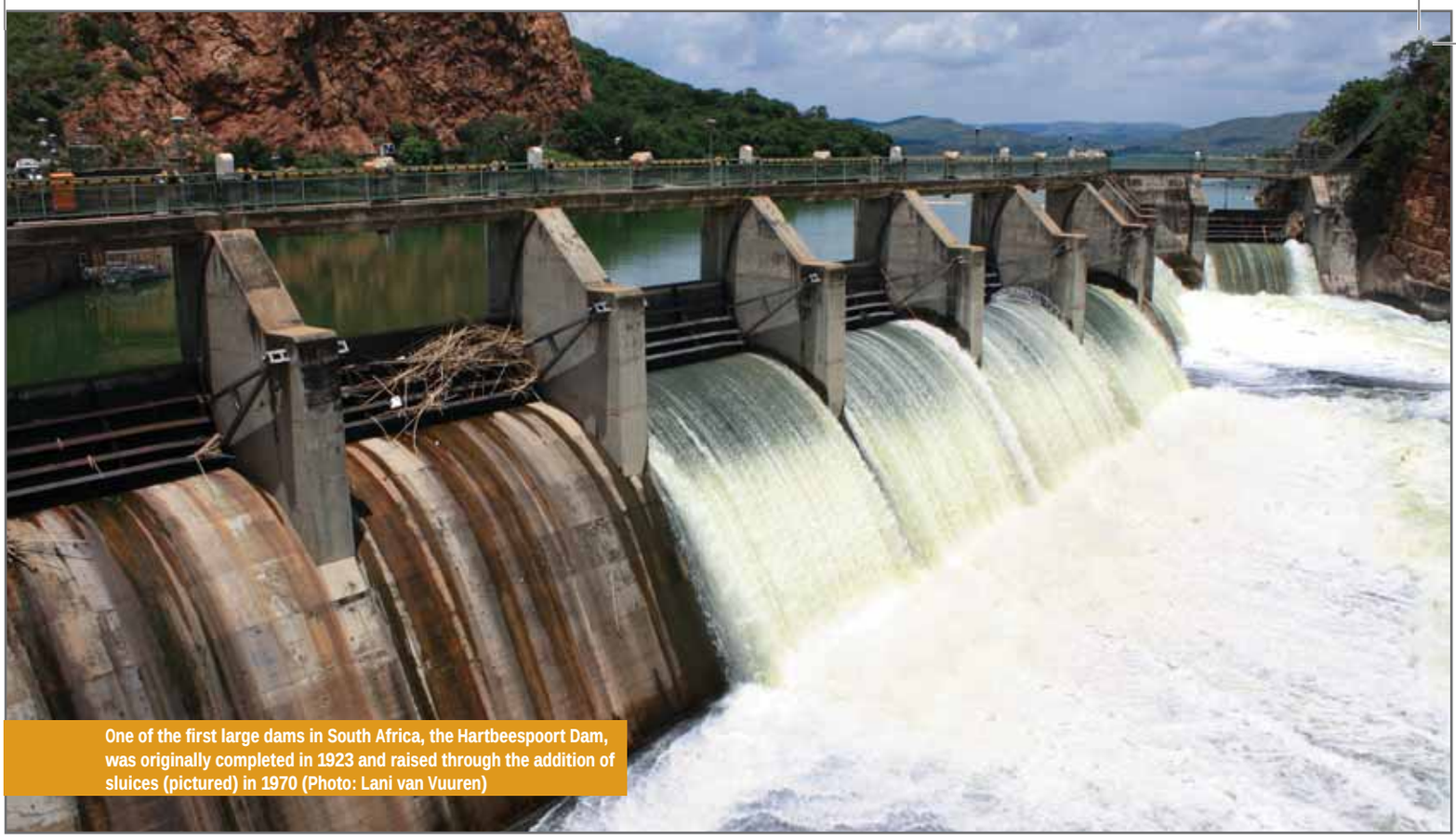
The country was a relative late-comer to the modern dam construction boom, which started after the Second World War. Yet, while dam construction has slowed dramatically in South Africa in the last two decades, the country still occupies the number six spot on the list of the International Commission on Large Dams (ICOLD), which ranks member countries according to their number of large dams. By 2012 a total of 4 755 dams had been registered with the Department of Water Affairs (DWA) Dam Safety Office (including medium large-sized dams).

This article explores the evolution of environmental awareness in the water resource development sector – more specifically within the DWA as the country's main designer and builder of large dams.

LARGE DAMS AND THE MODERN ENVIRONMENTAL MOVEMENT

Despite its historic political isolation South Africa was not immune to the global environmental movement. While the post-Second World War period gave rise to the construction of the largest dams in the world it also gave rise to the modern environmental movement as people became more concerned over the state of the world's natural resources, particularly as a result of overuse and pollution.

The introduction in the sixties and seventies of environmental assessment legislation and multi-disciplinary dam construction teams, which included landscape architects and ecologists, did not prevent the emergence of a highly politicised



One of the first large dams in South Africa, the Hartbeespoort Dam, was originally completed in 1923 and raised through the addition of sluices (pictured) in 1970 (Photo: Lani van Vuuren)

global anti-dam movement, which gained momentum from the eighties. This movement, led by political and human-rights activists, has been fuelled by the rise of environmentalism and has a strong political character.

A milestone in the history of large dams was the establishment in 1998 of the WCD (World Commission on Dams) to provide a global overview of the benefits and impacts of large dams. The Commission's final report, published in 2000, provides recommendations to improve environmental management around large dams going forward. Several countries have adopted these guidelines or derivatives thereof, including South Africa, although the application of WCD guidelines remains voluntary.

THE AWAKENING OF ENVIRONMENTAL CONSCIOUSNESS IN THE SOUTH AFRICAN DAM SECTOR

In line with international trends South Africa's water resources received more attention from 1944 as serious concern was expressed regarding the apparent deteriorating water quality in several areas due to pollution. In that year a committee was appointed by the Minister of Welfare and Demobilisation to "(Make an) (e)nquiry into, report on and make recommendations in connection with, incidence through the Union of bacterial and chemical pollution of water suppliers used or which may be used for domestic purposes for water supplies, including livestock in both urban and rural areas". At that stage limited legislation pertaining to the protection of the country's water against pollution was contained in the *Public Health Act of 1919*, the *Irrigation and Conservation of Water Act of 1912* (also known as the *Irrigation Act*), and the *Gold Law Act of 1908*.

It was not only authorities who became increasingly concerned over the deterioration of South Africa's water resources. From 1945 the engineering fraternity in South Africa was publicly voicing its concerns over the effect of water pollution on the country's aquatic wildlife. Through forums such as the South African Institution of Civil Engineering (SAICE), water engineers discussed the need for improved regulation to curb pollution,

The Orange River is South Africa's largest river, carrying 22% of the country's total river flow, and also boasts South Africa's largest dam, the Gariep (Photo: Lani van Vuuren)

The Vaal River – eutrophication was one of the first water quality problems to be investigated in South Africa in the 1940s (Photo: Lani van Vuuren)

and better regional development planning to prevent the over-allocation of water resources. Former SAICE President and Irrigation Department Director LA Mackenzie was particularly outspoken over his concerns regarding the direction in which South Africa's water resources was heading. In his 1944 presidential address he called for improved management of the country's water resources, particularly where the planning of new water infrastructure was concerned.

Mackenzie also initiated enquiries into the country's water laws and the activities of his department, eventually leading to the *Irrigation Act of 1912* being replaced with the *Water Act* (Act 54 of 1956). The Act included for the first time some measure of pollution control mainly aimed at discharges of effluent from industry.

INVOLVEMENT IN INTERNATIONAL COMMUNITIES

While South Africa became increasingly isolated after 1960 as a result of its political activities, both its scientific and engineering communities benefited from global interaction with professional bodies. Despite being barred from attending meetings in certain countries, aquatic scientists and water engineers were nevertheless exposed to the international environmental movement and discussions around dams and river ecosystems.

For South Africa's water engineers the country's membership of ICOLD, which it joined in 1965, proved crucial in moulding their thinking around the environment and dams. South Africa participated actively in ICOLD activities, with DWA senior officials (along with private engineers) regularly attending meetings and conferences, and contributing to technical committees. Although South Africa did not serve on the ICOLD environmental committee which was established in 1972 as a direct result of the United Nations Conference on the Human Environment, technical reports dealing with environmental matters were widely distributed among DWA engineers. Environmental awareness was also ingrained into the DWA culture.

In 1976 the country assumed a leadership role in ICOLD when Secretary of Water Affairs, Dr Jaques Pierre Kriel, was elected Vice-President of ICOLD. Kriel was a campaigner for cooperation between engineers and other science disciplines, including ecological scientists. He called on engineers to take more responsibility for the impact their developments had on the surrounding environment.

For Kriel the only way forward to achieve a balance between the protection of the environment and meeting the needs of a growing population was through compromise. As the head of the government's water department he would have had a considerable influence over government policy, and ensured the DWA's participation in and funding of multidisciplinary collaborative freshwater research programmes.

COOPERATIVE RESEARCH PROGRAMMES

Aquatic research in South Africa received a major boost through the country's involvement in the International Biological Program (IBP), which was launched by the International Council of Scientific Unions (ICSU) in 1964. In 1970 ICSU established the Scientific Committee on Problems of the Environment (SCOPE) to drive international research in the environmental field. A number of national collaborative research programmes were established in South Africa as part of SCOPE, most notably the National Programme for Environmental Sciences (NPES) under the auspices of the Council for Scientific and Industrial Research (CSIR) in 1972. For this discussion the most important sub-programme of the NPES was the multidisciplinary, cooperative, Inland Water Ecosystems (IWE) programme.

The IWE programme sought to investigate existing and projected impacts on the aquatic environment by anthropogenic actions and finding solutions for these problems. The initial focus on environmental problems on man-made water systems later shifted to incorporate more catchment-oriented research.

Information sharing was an important part of the IWE programme. The programme was administered by the National Committee for Environmental Sciences, which among others included representatives from national and provincial government, the Water Research Commission (WRC), the CSIR, and participating universities. In turn, smaller, technical committees with representatives from different disciplines and stakeholder groups gathered regularly in meeting rooms, at symposia and workshops, and during field visits to discuss environmental problems, the outcomes of research projects and the way forward.

As scientist RD Walmsley points out, the IWE programme was instrumental in "initiating, stimulating and coordinating research" between multidisciplinary parties from different organisations – particularly aquatic scientists and water engineers. Given the legislative and policy environment of South Africa's water sector at the time it is unlikely that any other forum could have been as successful in bringing people from these different sectors together to discuss water-related issues. Equally important is the fact that the programme emphasised the environmental impacts of dams in a scientific rather than in an alarmist manner, which resulted in an improved likelihood of buy-in from decision-makers.

Engineers and scientists agree on the indispensable value of the multidisciplinary and collaborative approach of the NPES. The abandonment of the programme in 1988 as a result of organisational restructuring was a tragedy for water research in South Africa.

Prof Will Alexander, who participated actively in the IWE from the time of its inception to his retirement from the DWA in 1984, comments thus on the repercussions of the termination of the programme: "All our hard work during the previous years of developing a multidisciplinary, multi-institutional approach to the growing environmental problems in our country came to nothing. Slowly the institutions in the natural sciences developed a grain silo approach as they were forced to compete for research funding."

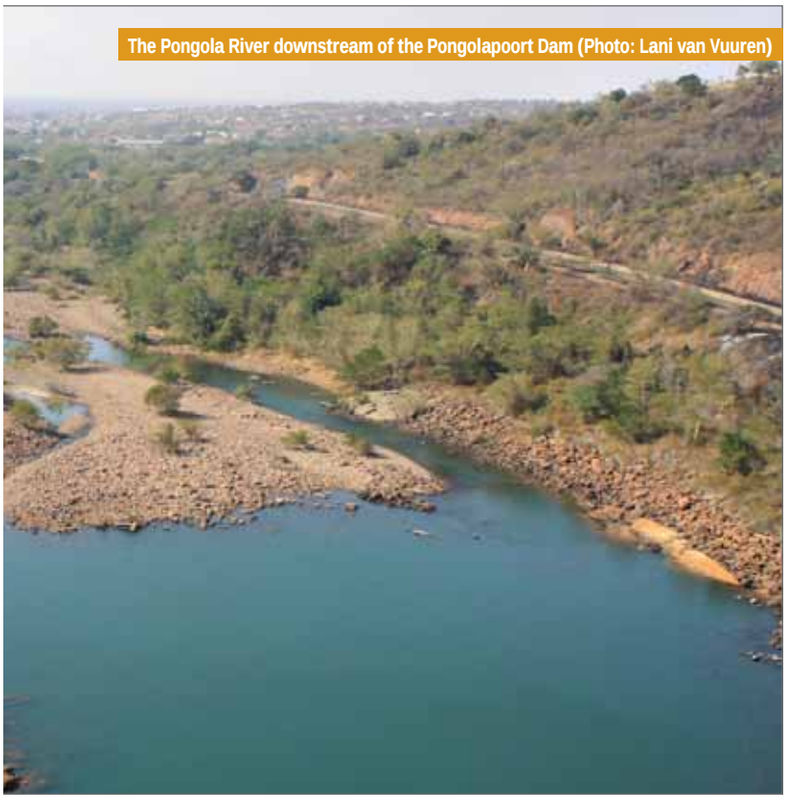
DAMS AND THE NATAL PARKS BOARD

Natal provincial authorities, most particularly the Natal Parks Board (NPB) and its scientists, played an important role in stimulating cooperation between DWA officials and aquatic scientists towards improved environmental management of the country's dams.

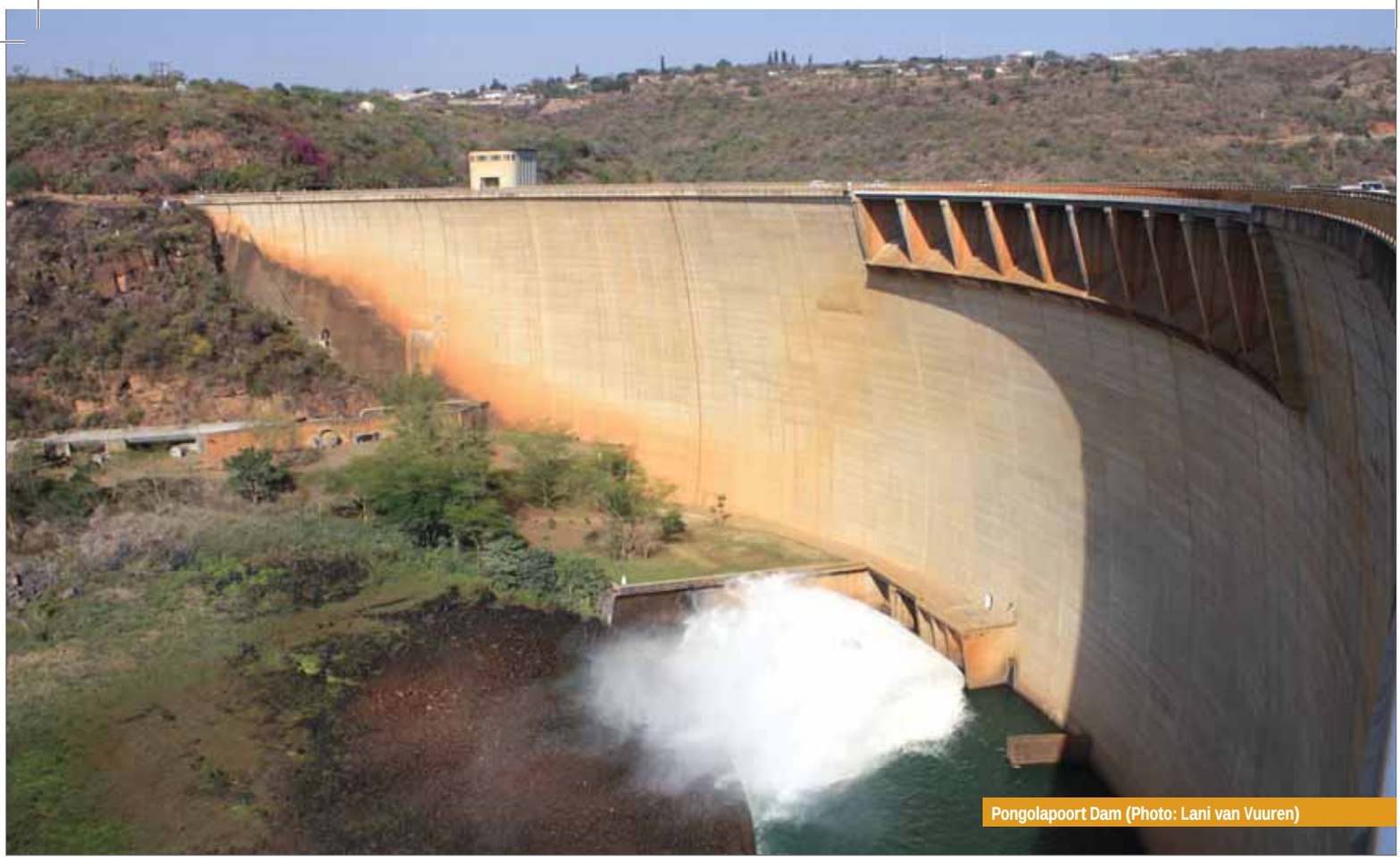
A major example of this is the collaborative research programme around the Pongolapoort Dam. The NPB was concerned about the potential impacts of the dam on the Pongola floodplain situated immediately downstream of the dam site. The annual inundation of the floodplain by summer floods re-energised a rich variance of ecosystem services that not only supported fish and animal life, but also a large community of people who depended on the floodplain for their livelihood. These floods would now be largely contained within the Pongolapoort Dam.

In 1967 NPB employee Mike Coke started research on the fish ecology of the floodplain lakes with a view of determining the effect of the dam. Coke's research subsequently underlined the importance of natural flooding to the life history of the fish species supported by the floodplain. The results of the research prompted the first meetings between the NPB and the DWA on mitigating the downstream effects of the Pongolapoort Dam.

The meetings were amicable – so much so that Coke and DWA Resident Engineer Roger Phélines, together with a colleague, went on to author a paper on the biological consequences of the Pongolapoort Dam, which was presented at the



The Pongola River downstream of the Pongolapoort Dam (Photo: Lani van Vuuren)



Pongolapoort Dam (Photo: Lani van Vuuren)

ICOLD conference in Madrid, Spain, in 1973. In 1974, as a direct result of these discussions, the University of Natal established a research station on site at the Pongola floodplain as part of the IWE programme. The Pongola Floodplain Research Programme was the first comprehensive study in South Africa focusing on water releases for human and environmental benefit, and remains unequalled in terms of scope and value.

When comparing the benefits of water use for irrigation with the benefits of water use for ecosystem services, the latter came out tops, and the results provided the basis for recommendations on how to manage flow below the dam, which the DWA accepted. Local water committees were subsequently spearheaded by the DWA to negotiate releases from Pongolapoort Dam. However, conflict of interest between, for example, fishermen and maize farmers, caused environmental releases to be placed on the back burner. No flood release date could apparently be found that suited all the role players.

Despite the challenges of implementing the environmental releases the Pongola Floodplain Research Programme has had an enduring influence over the South African water sector. Project leader Professor Charles Breen sums up the benefits of the programme: "[The research programme] set the platform for the DWA to begin to appreciate the importance of environmental flows and to collaborate with aquatic ecologists … It introduced people as integral parts of river ecosystems – a concept that would later become formulated as 'socio-ecological systems'."

In 1976 the NPB would play an important role again when it was appointed to undertake environmental impact assessment studies as part of the planned Mfolozi Dam. This was the first dam for which an EIA was done prior to construction in South Africa. The positive experience from this process prompted the DWA to subsequently pass a policy to voluntarily include EIA studies as part of all the department's bulk water resource development projects from 1980. A new division, namely Planning Services, was created within the DWA to oversee EIA studies.

DRAKENSBERG PUMPED STORAGE SCHEME

Another water resources development project which helped to institutionalise environmental matters in the DWA and promote cooperation between engineers and scientists was the Drakensberg Pumped Storage Scheme. Located in the foothills of the Drakensberg complex, the Drakensberg Pumped Storage Scheme formed part of the second phase of the Tukhela-Vaal Transfer Scheme, the first phase of which had been approved in 1970 to augment water supply to what is now Gauteng.

Concern from some of the owners of the farms that were to be expropriated for the project prompted the DWA to appoint an Environmental Committee for the Drakensberg Pumped Storage Scheme – the first such committee to be formed for a water resource development project in South Africa. The committee's main objective was to identify – and propose ways to mitigate – major environmental impacts of the scheme.

Various specialist studies were subsequently undertaken (while the project was ongoing), the results of which were used to compile an environmental impact report in October 1975. It is important to note that the study included only the Drakensberg Pumped Storage Scheme and excluded other elements of phase two of the Thukhela-Vaal Transfer Scheme. No ecological studies were undertaken to determine potential effects on the river system. Rather, the Committee focused on "harmonising of site components, minimal disturbance of the natural environment and site restoration".

Again it took compromise and partnership between engineers and scientists to work out the best ways to minimise damage to the environment, particularly since there was no environmental laws to govern the process. Through this project the DWA realised that managing dam construction with the environment in mind is not necessarily an added burden on the engineer, but that it can have

practical and financial advantages. A number of environmental measures taken, such as the use of grass rather than stone pitching on the downward slope of the Kilburn Dam, resulted in significant financial savings.

A major long-term recommendation of the Drakensberg Pumped Storage Scheme Environmental Committee was that environmental committees should be established for every large water engineering project.

CONCLUSION

In line with international trends, South Africa's dam construction sector showed strong growth in environmental consciousness following the Second World War. While internationally it was public conservation groups who placed increased pressure on authorities to implement environmental legislation from the sixties, which would eventually also pertain to the dam construction sector, in South Africa it was rather scientists who brought attention to the environmental impacts of specific dams in the country, while engineers themselves became increasingly concerned over the state of South Africa's rivers.

This shared concern between the different parties took an understanding and collaborative rather than a confrontational tone, and parties worked together voluntarily towards a state of compromise. The historically small size of the water sector also aided the fostering of professional and personal relationships between aquatic scientists and water engineers based on mutual respect, which helped tremendously when they had to negotiate ways to mitigate the environmental impact of dams.

The South African government, through the DWA and later the CSIR and WRC, expressed a willingness to invest in long-term, multidisciplinary, participative projects to garner the necessary scientific knowledge towards improved decision-making to better manage the environmental impacts of dam developments. Although it did not curb the construction of dams, it further fostered environmental consciousness among the South African water engineering fraternity and laid the foundations for the environmental Reserve which would later become a cornerstone of South African water law.

The results of the cooperation between aquatic scientists and engineers, the multidisciplinary research programmes, together with the outcome of early EIA studies, fed into the subsequent environment-related decision-making around dams, and the DWA's decision to voluntarily include environmental impact assessment and environmental committees as part of its bulk water resource development planning and construction process from 1980 –more than a decade before it became compulsory through national legislation.

The relationships built between DWA officials and the aquatic science community would stand the country's water sector in good stead after South Africa's democratisation in 1994 when the country's new water laws had to be negotiated, leading to one of the most progressive pieces of water legislation in the world in the form of the *National Water Act* (Act 36 of 1998). ☐

NOTE

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