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Development Steeped in Controversy

The necessity of the Pongolapoort Dam, one of the largest dams in South Africa, has been debated for decades after its construction. Lani van Vuuren takes a look at the development of this dam.

The Pongola River rises at some 2 200 m above mean sea level near Wakkerstroom, Mpumalanga, and descends steeply through the major portion of its catchment to the west of the Lebombo mountains. The Pongola passes between the Lebombo and Ubombo ranges through a narrow gorge (known as Pongolapoort) and the lower reaches of the river lie on the Maputuland coastal plain east of the mountains in northern KwaZulu-Natal.

Here, the river has a slope of 1 in 3 000; the abrupt change in gradient stems the flowrate of the river on the plain, causing a deposition of part of the sediment load and the flooding of extensive areas adjacent to the river course. This broad alluvial plain, known as the Pongola floodplain, extends from the gorge to the confluence of the Pongola and the Usutu rivers, close to the border with Mozambique.

SOUTH AFRICAN HERITAGE

The Pongola floodplain is one of the most biologically diverse ecosystems in South Africa. The complex of lagoons, oxbow lakes, marshes, forests, levees and floodplain grassland provide habitat for a very wide variety of birds, fish and animals. Importantly, the area is home to thousands of people from the ama-Thonga culture, who have lived adjacent to the floodplain and subsisted off the resources it provided for hundreds of years. Prior to construction of the dam, summer flooding inundated the floodplain creating a diverse set of environmental

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conditions and when these floodwaters receded, rich soils were exposed. These soils were cultivated as they dried, providing a wide range of crops to local inhabitants. In addition to cropping, the natural resources of the forests adjoining the floodplain provided a variety of products for food, fuel, construction and traditional medicines. In winter, the floodplain provided grazing for livestock.

But it was the agriculture potential of the adjacent Makatini flats rather than the value of the floodplain ecosystem services that drew the attention of the National Party government. Long before the decision was uttered to build the Pongolapoort Dam in 1960, the area to the east of the gorge was earmarked for white farmer upliftment, particularly through sugar cane production.

PONGOLAPOORT DAM – QUICK FACTS

Type of dam: Double-curvature single-arch
Height above lowest foundation: 89 m
Length of crest: 515 m
Gross capacity: 2 500 m³
Volume content of dam: 575 000 m³

IRRIGATION FARMING

In the Depression years of the 1930s, a government irrigation settlement was established upstream of the dam, on the west side of the Lebombo mountain. This settlement comprised 159 plots with a total area of 6 189 ha. A sugar mill was constructed in 1954. Water for irrigation was provided either by government-built gravity canals or direct pumping from the river. (This settlement, which is today the town of Pongola, is still strong today)

By 1955, plans were well advanced for the construction of a dam in the Pongolapoort. The dam was to be big enough to support 40 000 to 50 000 ha of irrigation on the Makatini Flats, a highly fertile area adjacent to the floodplain on both sides of the river. Apart from boosting commercial farming, the government also hoped to 'stabilise the frontier' bordering Mozambique and Swaziland. At the time, it was believed that development would automatically follow impoundment and so not much consideration was given to alternative development options.

Interestingly, merits of the scheme were a subject of debate even after construction started. One of the main grounds of criticism was that intensive soil and other tests, which would determine suitable land usage, were only undertaken after the project was given the go ahead.

After the scheme was announced it took three more years of preliminary work before construction of the actual dam started in 1963. Four suitable sites were investigated. Siting was complicated by the underlying geological conditions. The dam is founded mainly on good-quality dacite of the Lebombo Group, but the presence of deeply weathered breccia dykes crossing the river at almost right angles strongly influenced the founding conditions.

In order to avoid crossing the two largest breccia dykes, the dam had to be sited so far downstream that the upper flanks could not make optimum use of the site topography. The dam was eventually located at the eastern end of Pongolapoort.

A DAM IN THE MIDDLE OF NOWHERE

Prior to the construction of Pongolapoort Dam, the area was fairly isolated. There were no communications or services of any sort and, according to media reports at the time, resident engineer Mr RF Phélines spent the early years of construction sleeping in a tent.

Before building of the dam itself could start, a heavy-duty road was constructed over the Lebombo mountains to the

railhead around 30 km away. A village was also erected to house staff, with a compound for the estimated 900 black workers employed on the project.

Until work started on the Gariep Dam in 1966, Pongolapoort was the largest dam under construction in South Africa. It is a medium thin, double curvature arch dam with a gradual transition towards a gravity thrust block on the left flank. It has a maximum height of 89 m and a crest length of 515 m. The dam has a controlled and an uncontrolled spillway. The gross capacity of the reservoir is 2 500 million m^3, which is more than twice the mean annual runoff. The chute spillways have a combined capacity of 2 010 m^3 at high flood level. The thickness of the wall above the cushion is 18,3 m tapering to 8,2 m at the spillway and then flowing to 11 m to carry a road across it.

The foundations and abutments of the dam presented a number of challenges. During excavation for the foundation, great difficulty was experienced as a result of the sensitivity of the brittle dacite to blasting and stress relief and its reaction to changes in temperature. In the South African National Committee on Large Dams' publication ***Large Dams and Water Systems in South Africa*** it is written: "Whole layers of what appeared to be sound rock scaled off with a noise like a pistol shot and necessitated the use of 30 m-long rock anchors, line drilling and the use of hydraulic wedging for final excavations."

Work on the dam was on a 24-hour basis, requiring up to 764 m^3 of concrete a day. The aggregate came from a site 20 km upstream; some two million tons had been stockpiled at the start of the project.

Another significant challenge was the high average air temperatures on the site. This was overcome by pre-cooling the aggregate with controlled amounts of crushed ice. Pongolapoort Dam was the first dam in South Africa where this artificial cooling method was used. At a later stage, piped cooling systems, which gave better control, were used in the construction of the Gariep and Vanderkloof dams.

The dam went up in 1,8 m sections, the curvature of each one having to be separately calculated, taking about 30 hours on a manual calculation. Each vertical section is independent of the other. The gravity sections on the flanks induced blasting of some 500 000 t of rock. The dam was eventually completed in 1973.

It has to be noted that the envisaged large-scale irrigation development never occurred following the completion of the dam. This was due to, among others, a significant drop in the price of sugar. Today, only about 3 000 ha of irrigation has been created.

MAINTAINING THE FLOODPLAIN

The building of the dam and planned irrigation developments of the area focused attention on the unique floodplain ecosystem downstream of the scheme and the plight of the AmaThonga people dependent on the ecosystem services it provided. The completion of the dam resulted in the flow of the river to the floodplain being regulated. Strong voices were heard from the research community for releases from the dam to stimulate the natural flow regime and thus maintain the floodplain integrity.

A multidisciplinary research programme was initiated by Prof Charles Breen and Jan Heeg of the University of Natal in the 1970s with the aim to understand the floodplain as a social-ecological system. "Even today we would consider this an unparalleled exercise in environmental flow determination because it had the express objective to deliver both social and environmental justice," explains Prof Kevin Rogers, Director of the Centre for Water in the Environment at the University of the Witwatersrand.

Kevin Rogers

Right: Fish was an important source of food for people of the floodplain. Traditionally fish were caught using weaved baskets known as isifonyo.

"The research was the first in this country, and arguably internationally, to propose flow releases from a dam to maintain ecosystem services delivery to people, and as such was an important precursor to our current concept of the Ecological Reserve, which has the same purpose," Prof Rogers explains. "The government of the time was sympathetic to a concept of 'water for ecosystem maintenance' but needed much convincing that the Pongola floodplain should take preference over agricultural development."

Pongolapoort Dam as seen from the air.

An ingenious cost/benefit analysis by Breen and Heeg, however, clearly demonstrated that using 14,6% of mean assured yield to inundate the floodplain should generate the required ecosystem services which would be of much greater economic and social benefit than if that water were used to grow sugar cane under irrigation. The government was convinced and preparations then began to implement flow management in the 1980s.

However, in the early years following its completion Pongolapoort Dam could not be filled as it would inundate part of Swaziland. While negotiations with Great Britain prior to the independence of Swaziland had solved the problem of inundation, these decisions were withdrawn by Swazi authorities following the country's independence.

During this time floodwater had to be discharged through the scour outlets. These outlets were not designed for that purpose, however, and were subsequently damaged. These damages necessitated the replacement of the sleeve valves which, in turn, reduced the capacity of the scour outlets by 36%.

Both the political and engineering problems were overcome by 1982. This was none too soon because in 1984 the area was hit by tropical cyclone Domoina. A 1985 Department of Water Affairs report on the effects of the cyclone describes that in January when Domoina hit, the catchment of the dam received more than 700 mm of rainfall (a record to this day). A peak inflow of 1 600 m^3/s occurred into the Pongolapoort Dam on 31 January 1984. This peak was 18 times higher than the previous highest recorded peak. At the time the dam was only 13% full. The total inflow as a result of the cyclone was 2 000 million m^3 or 87% of the total capacity of the dam.

FLOODING TOO EARLY OR TOO LATE

During the 1970s social, ecological and hydrological scientists funded by the Cooperative Scientific Programmes gained a detailed understanding of the Pongola social-ecological system. It was clear that unless water was delivered to the floodplain at particular times of the year, for particular durations and to achieve a certain level of flooding, water quality would decline, organisms would not complete their lifecycles and people's livelihoods would be in jeopardy as ecological service provision was disrupted.

The scientists proposed a flow regime that should maintain the integrity of the ecosystem, and ecological services to the people, yet have minimal effect on irrigation potential. Winter flows in the Pongola River were set to be around 2 m^3/s to meet the requirements of local people but also those stipulated by Mozambique.

Periodic increases in flows (about 80 m^3/s) in early summer (November to January) would replenish the water in most floodplain pans, and a large flow (600 to 800 m^3/s) sometime in February would inundate the floodplain to high flood level. The early summer flows were planned to flush out saline water and refresh water available to people and livestock at the end of the dry winter. The February flow would provide the cue for fish migration and breeding, and the plant growth that followed the receding water provided grazing during the winter months when grazing off the floodplain was limited.

WATER FOR PLANTS OR FOR PEOPLE?

Relative to the detailed flow regimes of current day Ecological Reserve that for the Pongolo was simple, yet more than 25 years later none of its components, let alone the regime, have been implemented. While many issues have clouded decision making over this time, one of the main problems has been confusion between whether flow releases from the dam should be for the delivery of ecological services or agriculture on the floodplain, notes Prof Rogers.

Once the research process had delivered the proposed flow regime funding dried up and the hydrological and ecological researchers moved on to other projects. During the final years of the programme, however, social scientists had suggested that traditional farmers switch from their usual multi-coloured maize to white maize, which had the potential to give a higher yield.

Within a few years white maize became the main crop, but since it had a much longer growing period that the traditional variety, fields were sometimes destroyed by floods that arrived before the grain was mature. Farmers, with the assistance of ex-social researchers, therefore persuaded dam operators that the proposed between-flood periods should be extended to allow the maize to mature.

The traditional multicoloured cob cultivated on the floodplain.

Kevin Rogers

This began an unstructured process of so-called 'negotiated' releases that has essentially ignored the regime proposed by the original research team and its purpose of generating ecosystem services. Between 1984 and 2005 some 25 releases were made from the dam. In some years there were no releases, in others two or three, and they came at any time of the year.

"Consequences of this unstructured decision making in a policy vacuum were soon felt throughout the social and ecological system," notes Prof Rogers. "Fish stocks declined rapidly as adults were not ready to spawn in the cold of July or water levels fell too fast for juveniles to establish in the population. When floods were far apart evapo-transpiration losses of water resulted in many of the channels and oxbow lakes of the floodplain drying up, killing many aquatic organisms."

Traditionally, people had not fenced their fields on the floodplain because these water bodies prevented cattle from accessing them during the growing season. Now that they were drying up the cattle had easy access to the diverse crop lands that had fed the people for centuries. "Serious conflict was reported between the agriculturists, graziers and fishermen within a community that no longer had the surety of food supply they had been used to under the natural flow regimes."

LOOKING TO THE FUTURE

Almost 40 years after the construction of the Pongolapoort Dam, management of its waters is still the subject of contention. What future does this seemingly large white elephant hold under South Africa's new legislation?

Government authorities have not written off the Pongolapoort Dam. Utilisation plans have been drawn up for the dam, focusing on its potential as an eco-tourism draw card and its potential as a water resource for domestic water supply in the area. The area around the dam certainly has a high conservation value, and today much of it is protected, either as a public nature reserve, private game farm of communal protected area. It is said that the dam could play a particularly important role in the Lebombo Spatial Initiative, an ambitious project that involves the regional interests of South Africa, Swaziland and Mozambique.

However, the fate of the downstream floodplain ecosystem remains unresolved despite its unique place in the history of water resource management in South Africa. "This country is hailed for its innovative water policy based on an Ecological Reserve to ensure delivery of ecosystem services to society. The origins of the Pongola floodplain and Pongolapoort sagas preceded this law, but the social conflicts and confusion about the purpose of managed flows persist more than ten years after its promulgation," notes Prof Rogers.

Will the spirit and letter of the National Water Act prove strong enough to restore the ecological services of the Pongola floodplain upon which so many poor people depend?

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