CAN THE ZAMBEZI IRRIGATE THE KALAHARI?

Chris Nugent

Department of Geography, University of Zimbabwe

The development of Southern Africa from the Namib in the west, through the Kalahari to Hwange National Park is limited by the scarcity of one natural resource – water. Yet the region is bordered on its north-eastern margin by the Zambezi, Southern Africa's largest river.

Proposals to use the Zambezi's water to irrigate the arid interior were first made by Professor Schwarz (1920). Schwarz suggested that a barrage across the Linyanti (Chobe) River could create a huge lake over the relatively flat terrain of the Northern Kalahari, and would flood southwards to innundate the Makgadikgadi Pans. He suggested, rather optimistically, that evaporation from such a lake would increase rainfall over a vast area extending into the Republic of South Africa.

The department of irrigation, Pretoria, commissioned a study of Schwarz's proposals. This was most ably completed by a team led by Dr. A. L. du Toit, who submitted a report in 1926. Du Toit (1926) showed that there are no suitable dam sites on the Chobe River but that a dam on the Zambezi at Katembora, 15 km downstream of Kasungula, is technically feasible. He showed however that such a lake would have a limited and strictly local effect on the rainfall. Du Toit pointed out that the Okavango River already loses practically all its discharge from its delta, yet appears to have a minimal influence on the rainfall on its semi-arid southern margin.

A barrage at Katembora was reconsidered during the early part of this decade (see Clayton, 1985). This time the object was not irrigation but power. The Katembora barrage could channel the Zambezi into a conduit which would use the drop at the Victoria Falls to generate hydro-electric power. The scheme has several major problems:

1. High evaporation from a large, shallow lake would reduce the water available to Kariba Dam.
2. The scheme would divert most or all the water from Victoria Falls, with obvious implications for tourism.
3. The lake would innundate parts of four countries, posing a complex political problem.

Several more appropriate dam sites exist on the Zambezi and the Katembora scheme was once again shelved.

Modern proposals

Utilising Zambezi waters to irrigate the Kalahari and supply the Witwatersrand industrial complex has been reconsidered in a recent paper by Borchert and Kempe (1985). These authors point out that water availability will become more critical in Botswana and the Republic of South Africa, as the populations of these countries is expected to double over the next 25 years. By the turn of the century, water demand is expected to account for some 92% of available resources. Acute water shortages, resulting from local variations in supply and demand, are likely to be experienced long before this.

The solution envisaged by Borchert and Kempe is to divert water from the Chobe River just upstream of Kasangula, which is itself supplied largely by the Zambezi. The water would be pumped onto the fault scarp that forms the Chobe's right bank and fed along an aquaduct to the Makadikgadi Pans (Fig. 1). From here the water would have to be pumped onto a second fault scarp, that forms the south-eastern margin of the pans complex and allowed to flow along a second aquaduct to a third pumping station situated to the north-west of Gaborone. That part of the flow not required by Botswana would then be pumped a third time to flow into South Africa, crossing the border near Lobatse. The total length of aquaduct from the Chobe River to Lobatse would be in excess of 1 000 km.

Borchert and Kempe calculate that in order to move 2,4 cubic kilometres of water annually, the aquaduct would have to be some 20 m wide at the water surface and 5 m deep. These values decrease somewhat in a downstream direction, as water is drawn off for use in Botswana. The cost of building such a structure is estimated at Z$8 500 million. This could be written off at 15% p.a., bringing the annual cost of running and maintaining the system to some Z$3 550 million. Borchert and Kempe thus calculate the final cost of water delivered by the scheme at Z$1,50 per cubic metre. This is the cost of carrying water from the Zambezi to the communities involved and does not include the cost of running and maintaining the regional supply network. This charge is thus additional to costs already incurred in taking water from local sources.

The scheme presented by Borchert and Kempe would involve building the world's longest aquaduct across some of the world's least developed terrain. The high cost of this venture makes a careful assessment of its problems and risks a vital necessity. The problems outlined below are those that would affect the success of the scheme itself. Such a major structure would also have numerous affects on the fragile ecology of the Kalahari. The aquaduct could for instance block migration routes or lower the water table in some areas and would certainly increase the influence of man in a hitherto remote region. A full Environmental Impact Assessment would have to be conducted to ensure that other interests (e.g. wildlife, tourism) were not going to be seriously affected by the project.

The first set of problems would occur during the construction stage. This must begin with a major topographic survey to fix the alignment of the aquaduct. The course north of Makgadikgadi is helped by the natural slope of the land towards the south and southeast. The aquaduct will however have to traverse at least one major dune field and the extra cost of moving this sand must be considered. South of Makgadikgadi, the terrain is less regular, as numerous outcrops of pre-Kalahari "basement" penetrate the cover sands. It is not even clear that a route exists at all and this section of the course could involve the construction of one or more additional pumping stations.

The hazard presented by streams crossing the course of the aquaduct must be carefully considered in each case. Although the annual flow of the streams is typically small (the largest being the Nata River, which flows from the Zimbabwe border), flow is concentrated in flash floods which are often very powerful and could wash away sections of the aquaduct. In these sections the aquaduct would need to bridge the stream in some way, raising construction costs further.

Once running, the system will lose water in two ways. Borchert and Kempe calculate an annual water loss in evaporation of 0.072 cubic kilometres, only 3% of the volume carried. A more serious loss would be from seepage into the concrete walls and floor of the channel. This would vary according to the materials used but would probably exceed 10% of flow.

Numerous physical problems are likely to plague the smooth running of the system. Although the waters of the Zambezi and Chobe Rivers near Kasungula are very clean, a certain amount of suspended sediment would be pumped into the aquaduct and this would be supplemented by wind borne dust along its route. This material could accumulate, especially in sections whose slope is less than optimum. Periodic manual removal of sediment could thus become an additional cost.

Tectonic earth movements could prove to be a problem, where the aquaduct crosses faults. The Chobe Swamps and parts of the Kalahari are seismically active and earthquakes up to magnitude 6,2 have been recorded at Maun, on the south-eastern edge of the Okavango Delta. Even smaller shocks could fracture the concrete channel and necessitate emergency repairs. The performance of an aquaduct, like a chain, is only as good as its weakest link. Problems such as siltation, fracture of the channel or mechanical breakdown at any pumping station would bring the whole system down, resulting in additional expenses in terms of repairs and lost production time.

Despite the formidable physical problems that would be encountered during construction and maintenance, the considerations that are likely to prove more decisive for the implementation of this scheme are political and strategic. The Zambezi is an international river, in which several countries have a share. Zimbabwe, Zambia and Mozambique use the streamflow for generating electricity, at Kariba and Cabora Bassa. The proposed aquaduct would draw water from the river amounting to about 5% of the discharge at Kariba and would thus reduce electricity production by this amount.

This situation is covered by the Helsinki rules on the uses of the waters of an international river, article IV of which states:

"Each basin state is entitled, within its territory, to a reasonable and equitable share in the beneficial uses of the waters of an international drainage basin".

Botswana is thus entitled to draw water from the Zambezi for uses within its territory. In order for the scheme to be cost effective however, most of the water must be sold to South Africa. The government of Botswana would therefore have to negotiate with the states downstream and presumable compensate them in proportion to the losses they will incur.

The main beneficiary of the Kalahari Aquaduct is likely to be the Republic of South Africa, who would receive most of the water for industrial and domestic purposes on the Witwatersrand. It therefore follows that once the aquaduct has been established and South Africa has become dependant on the water, any long term break in supply would have severe economic consequences for that nation. Under prevailing circumstances, the aquaduct would become a prime military target for the various political organisations seeking to overthrow the Pretoria government. The Kalahari Aquaduct would therefore become a strategic liability analoguous to the Beira Corridor but far less easily defended due to its great length and the ease with which sections could be destroyed. It is my opinion that if the Kalahari Aquaduct is to be built at all, it must await the establishment of a representative and acceptable political order in South Africa.

References

Borchert, G. and Kempe, S. (1985). A Zambezi Aquaduct. *Mitterlungen geologische – palaeontologishe institute,* University of Hamburg. SCOPE/UNEP supplement **58**, 443-457.

Clayton, S. (1985). Hydroelectric development in Zambia – past and future. **In:** Handlos, W. L. and Howard, G. W. **(Eds.)** *Development prospects for the Zambezi Valley in Zambia.* Kafue Basin Research Committee. pp66-84.

Du Toit, A. L. (1926). *Report on the Kalahari Reconnaissance of 1925.* Dept. of Irrigation, Pretoria. 69pp.

Schwarz, E. H. L. (1920). *The Kalahari or thirstland redemption,* Cape Town.

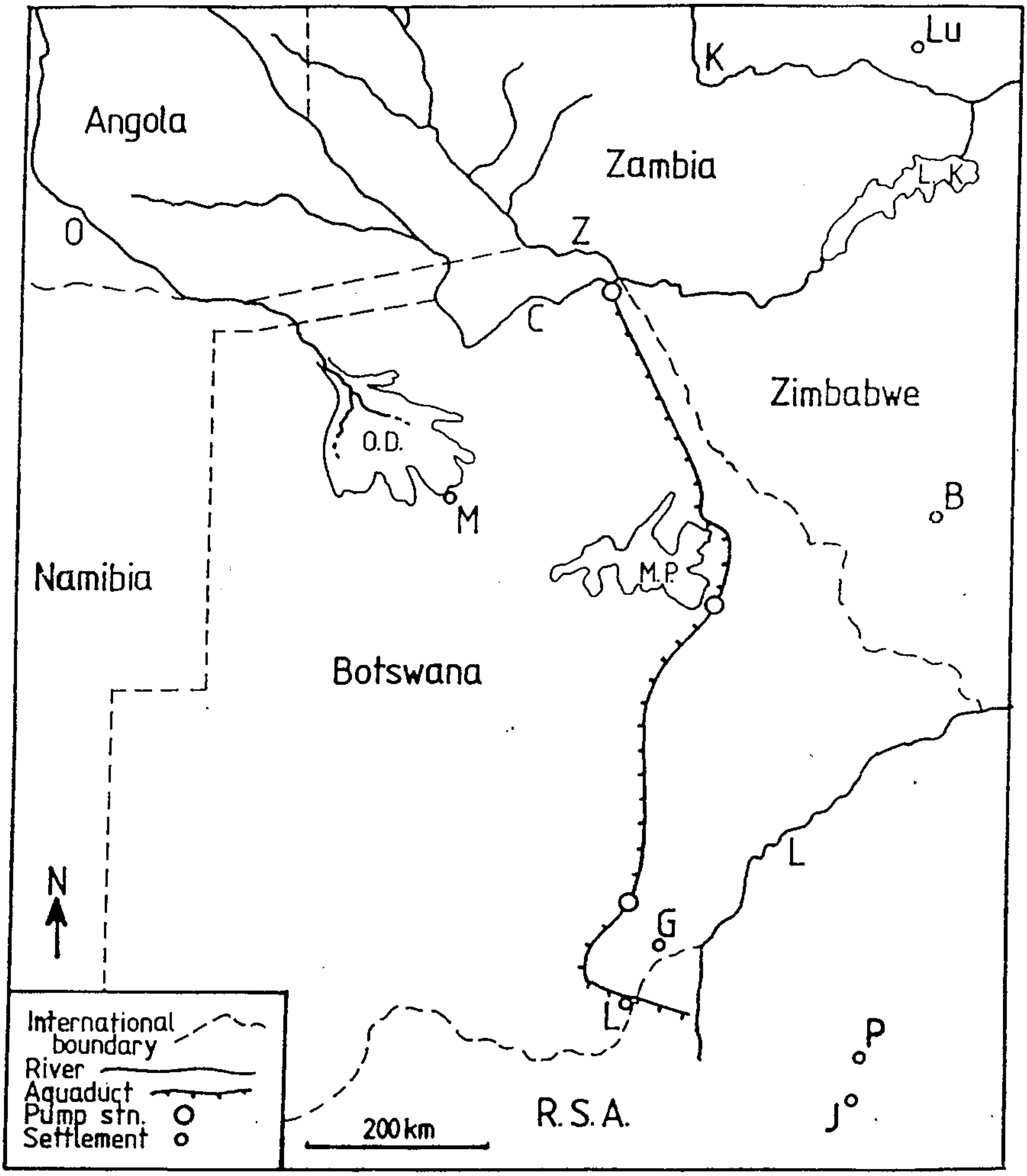

Fig. 1 The Kalahari Aquaduct – Proposed route.

Legend:

B	=	Bulawayo
G	=	Gaborone
L	=	Lobatse
M	=	Maun
J	=	Johannesburg
P	=	Pretoria
Lu	=	Lusaka
R.S.A.	=	Republic of South Africa
Z	=	Zambezi River
C	=	Chobe River
O	=	Okavango River
L	=	Limpopo River
K	=	Kafue River
L.K.	=	Lake Kariba
O.D.	=	Okavango Delta
M.P.	=	Makgadikgadi Pans