ELSEVIER

Water Policy 2 (2000) 65–81

Water Policy

www.elsevier.com/locate/watpol

Management of shared river basins: the case of the Zambezi River ☆

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1. Introduction: the Zambezi River Basin and its hydrology

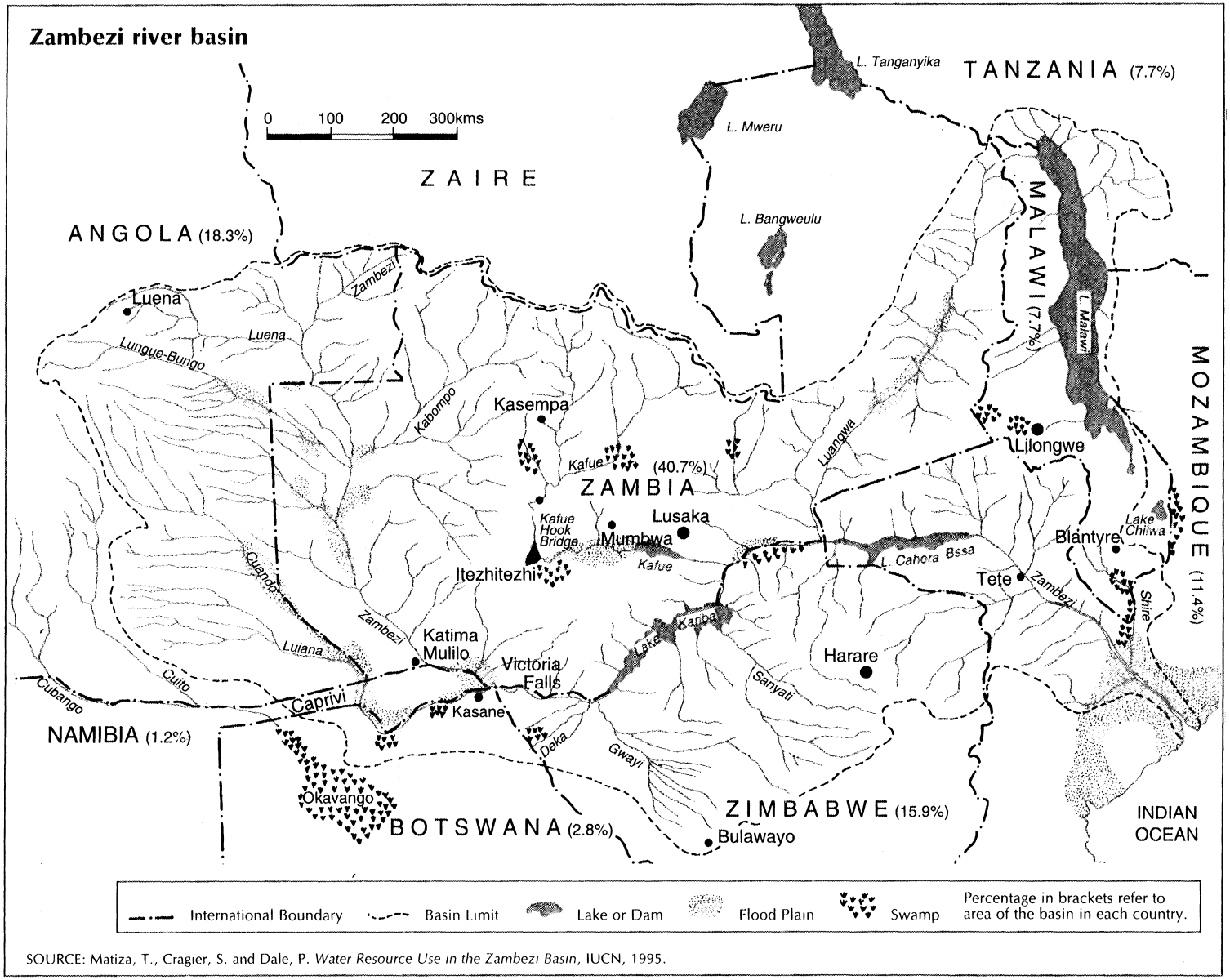
The Zambezi River, lying wholly within the SADC, is the largest watercourse system in the region. Its catchment area is some 1,300,000 square kilometres, occupying the territories of Angola, Botswana, Malawi, Mozambique, Namibia, Tanzania, Zambia and Zimbabwe. Out of these riparian states, Zambia, Angola, Zimbabwe, Mozambique and Malawi have the largest share of its basin, with catchment area percentages of 40.7, 18.3, 15.9, 11.4 and 7.7, respectively. The major tributaries are Shire River from the territories of Tanzania, Malawi and Mozambique, the Luangwa, Kafue and Kabompo river basins lying wholly within the territory of Zambia, the Luena/main Zambezi river from the territory of Angola while the Cuando/Chobe River is in the territories of Angola, Namibia and Botswana (see Map 1).

The distribution and occurrence of water resources in the basin is dependent on its rainfall, evaporation and hydrological processes. The rainfall averages 990 mm/a, but varies considerably across the catchment itself (Trolldalen, 1996). The northern parts of the basin (Malawi, Tanzania, northern and north western Zambia) have an average annual rainfall of 1200 mm/a while the southern and south western parts average around 700 mm/a. The atmospheric feedback or evaporation component of the hydrological cycle is also quite variable, with an annual average of 870 mm/a and the local averages varying from 1000 mm/a in the Luangwa, Shire and lower parts of the catchment down to 500 mm/a in the south western areas of the basin. These seasonal and spatial variations in rainfall and evaporation lead to complex runoff patterns with the annual volumes of run-off being relatively small.

The volume of annual renewable water resources in the Zambezi River is estimated to

☆ Slightly revised paper originally presented at the SADC-EU Conference on the Management of Shared River Basins, Maseru, Lesotho, 20–21 May 1997. Note that the views expressed in this paper are those of the author and not of Malawi nor SADC.

1366-7017/00/$ - see front matter
PII: S1366-7017(99)00022-7



SOURCE: Matiza, T., Cragier, S. and Dale, P. *Water Resource Use in the Zambezi Basin*, IUCN, 1995.

Map 1. Zambezi River Basin, its tributaries, lakes, and riparian states (source: modified from Chenje and Johnson, 1996: xiv).

average some 3600 m^3/s or 87 mm of equivalent rainfall, which is just under 10% of the average rainfall in the basin. The annual and seasonal flows for the Zambezi River and its major tributaries of Shire, Luangwa, Kafue, Kambopo and Luena/Zambezi rivers are presented in Table 1.

The small difference in seasonal flows of the Shire River reflect the reservoir effects generated by Lake Malawi. The less variable flows in the main Zambezi River are also attributed to reservoir effects caused by its long channel storage, reservoirs and lakes. The tributaries of Chobe/Cuando, Luanginga and Lungue Bunguo, Gwayi and Sanyati rivers occupy large proportions of the Zambezi River basin but make little contribution to its flows compared to those listed in Table 1. These rivers are in sub-catchments which are relatively dry.

2. Water resources management

Each riparian country monitors, assesses, plans, develops, conserves and protects water resources of that part of the Zambezi River in its own territory. The utilisation of the water from water resources developments is also done at country level, with little consultation and co-operation among riparian states. Traditionally, riparian states have not seized the opportunities for joint water resources management, except in isolated cases.

2.1. Water resources monitoring and assessment

Data collection and water resources assessments started at the beginning of the century with the recording of water levels of Lake Malawi in 1896, the gauging of the flows of Kafue River near Kafue Town and those of Zambezi River at Victoria Falls started in 1905 and 1907, respectively. However, most hydrometeorological data in the basin began in the 1950s, with continuous records per station, except in Mozambique and Angola where civil wars disrupted the operations of hydrometric stations. The quality of data available is considered fair to good, although the hydrological services continue to deteriorate and data collection programmes are getting poorer due to financial and institutional capacity constraints (World Bank, 1991).

In recent years and with the advent of SADC, attempts have been made to establish joint

Table 1
Runoff of Zambezi River and its main tributaries (m^3/s)[a]

Name	Annual	Wet season	Dry season	Catchment area (km^2)
Zambezi River at sea	3600	5000	1500	1,300,000
Shire River basin	500	550	360	150,000
Luangwa River basin	620	1500	90	144,000
Kafue River basin	350	450	100	152,000
Kambopo River basin	260	400	120	67,000
Zambezi River at Kariba	1350	1500	900	664,000
Zambezi River in Angola	670	900	150	76,000

[a] Source: estimated from ZESCO, 1991.

water resources monitoring and assessment in the Zambezi River. In 1988 or thereabouts, the SADC Energy Sector came up with the 'Hydroelectric Hydrological Assistance' project whose objective was to improve the availability of hydrological data for hydropower development and operations. By 1993, the project had developed a telemetry system for the upper Zambezi River in Zambia and Zimbabwe. The historical data was compiled, processed and stored into a database. The power utilities in Zambia and Zimbabwe are using this database and the telemetry system, especially in forecasting the inflows in Lake Kariba and scheduling dam operations. Unfortunately the monitoring and assessment does not extend outsize Zambia and Zimbabwe, as originally planned.

The 'Development of a Unified Water Resources Quantity and Quality Monitoring System for Zambezi River' was another attempt to have a common monitoring and assessment scheme. This is the ZACPRO 5 project of the Zambezi River Basin Action Plan (ZACPLAN), which aims at the environmentally sound and integrated water resources management for the entire Zambezi River basin. The programme began in 1991 and has not been completed. It recommended a network of hydrometric and water quality monitoring stations which left important tributaries and main river sub-basins without stations. Under the ZACPRO 6 project, this network was significantly updated in 1994 and a basin wide database was established based on data collected from its stations. This notwithstanding, there are no joint monitoring programmes. The stations identified in Angola and some in Mozambique are also not yet operational.

2.2. Historical water resources development perspective

Water resources planning and development has largely been based on national policies, with each country making arrangements and implementing plans for the development of its own utilisation requirements. Most of the development plans are identified and upgraded from the plans of the 1950s by the colonial governments. The Kariba Dam and hydropower plants, for example, were planned and developed in the 1950s under the auspices of the Federation of Rhodesia and Nyasaland, FRN. The Federal Government established the Central African Power Company (CAPCO), which later became Zambezi River Authority (ZRA), to develop, own and operate the Kariba complex.

A similar large water resources development is the Cabora Bassa dam in Mozambique built by the Portuguese in 1974. The building of the Cabora Bassa complex followed after an agrement with South Africa that made provisions for the export of electricity generated from hydropower plants at the dam to the Republic of South Africa.

There have been proposals to collaborate in the development of Lake Malawi, Shire River and lower Zambezi River in the past. The Federation of Rhodesia and Nyasaland, FRN, in collaboration with Portuguese East Africa (Mozambique), developed a plan between 1952 and 1954, where the Lake Malawi levels and Shire River flows would have been stabilised using barrages and dams (Sir Williams, Harclow & Partners, 1954). The stabilisation was intended to benefit hydropower development (on the Shire River), flood protection, irrigation and inland navigation. The navigation component centred on connecting land locked Malawi (then Nyasaland) and interior Mozambique to the sea (Beira) through the Shire and Zambezi rivers. There were proposals for development of inland ports at Bangula on the Shire River and at

Sena on the Zambezi River. Although the project was expected to benefit Mozambique as well, it died with the crumbling of the FRN in the early 1960s.

2.3. Water resources utilisation

2.3.1. Non-consumptive uses

2.3.1.1. Hydropower. There are some 4500 MW of electricity generated from installed hydropower plants at Kariba, Cabora Bassa and Victoria Falls on the main Zambezi, Kafue Gorge on the Kafue River, Mita dam on the Lunsefwa River (a tributary of the Luangwa River). The installed capacity also includes that generated from Nkula and Tedzani on Shire River and a few more small hydropower stations in Malawi. It is also worth noting that an estimated 11,000 MW hydropower potential, mainly on the proper Zambezi River, is not yet developed within the basin. The proposed Batoka Gorge project, which is expected to be developed by ZRA in the near future, has 1600 MW of this potential (Table 2).

The water demand for hydropower generation on the main river is 1700 m^3/s and is likely to double soon with the pending installations at Cabora Bassa, that are expected to increase hydropower generation capacity to 4000 MW. It is quite unlikely that new major abstractions can be accommodated considering the present hydropower water commitments which are also not met due to the inadequate flows. However, alternative sources of electricity may free the committed flows for other uses such as irrigation and water supply. This has to be considered sooner or later, particularly with the mounting pressure to use the Zambezi waters for the benefit of the greater SADC region.

2.3.1.2. Fisheries. At least 200,000 tonnes per annum of fish are harvested within the basin. About 70,000 and 50,000 tonnes per annum come from Lake Malawi and the Zambia part of the Zambezi River basin, respectively. It is important to note that fish is the main source of animal protein for the majority of rural communities of riparian states.

2.3.1.3. Navigation. Passenger and cargo navigation services are mainly practised on Lake Malawi, having ports and boat facilities that handle more than 150,000 tonnes and 300,000 persons per annum, respectively. In fact, because of difficult terrain and inadequate road net-

Table 2
Major hydropower water demands and energy supply in Zambezi River

Hydropower plants	River/tributary	Energy (MW)	Required flow (m^3/s)[a]
Victoria Falls	Zambezi	108	150
Kariba	Zambezi	1266	1300
Kafue Gorge	Kafue	900	265
Cabora Bassa[b]	Zambezi	2000	1700
Nkula/Tedzani	Shire River	204	320

[a] Estimated from SSAHAP regional report.
[b] Installed capacity soon to increase to 4000 MW requiring water demand of 3400 m^3/s.

works around Lake Malawi, Kariba and Cabora Bassa, ships or boats are the only means of transporting goods and passengers for the majority of the lake shore settlements. The lakes of Kariba and Cabora Bassa are also popular for tourists and sports boating. Navigation on the main river itself is, however, limited by shallow depths, rapids and high flow velocities.

The lower Shire and Zambezi rivers were frequently used for navigation since the days of the famous explorer, Dr David Livingstone. Boats and barges used to transport cargo to and from Malawi, all the way to the port of Beira on the Indian Ocean shores, up to the late 1970s. However, these services stopped due to several reasons including the insecurity problems and shallow water depths in the rivers. There are long standing studies to investigate and make the Shire and the lower reaches of the Zambezi River navigable once again.

The Barotse flood plains of the Zambezi River in the Western Province of Zambia, are also navigable especially during the rainy season. Navigation in the Barotse flood plains is the only transport between Mongu, the provincial capital, and the west bank of the river. Navigation is also popular in the area as it is used for the centuries old traditional and cultural evacuation from and reoccupation of the summer and winter residences of the Barotse king, Litunga. It is traditionally known as ''Kuomboka''.

2.3.1.4. Ecology. The Zambezi River basin is also unique and important as a bio-diversity sanctuary, and therefore a popular destiny for water-related eco-tourism. For example, Lake Malawi has the largest number of fish species found in a single lake in the world, with 400+ identified fish species and more than 200 of these are endemic to the lake. The World Heritage sites such as Lake Malawi National Park, Victoria Falls and Mana Pools on the Zambezi River in Zimbabwe and Zambia are important wetland areas. These not only attract significant numbers of tourists who bring important foreign currency to the riparian countries, but are also important natural heritage monuments for present and future generations. Obviously, the aesthetics of these eco-tourism sites depend on quantity and quality of water resources around them. The Victoria Falls, for example, require at least 1000 m^3/s of flow to maintain spectacular scenes.

2.3.2. Consumptive uses

2.3.2.1. Water supply. The requirements for water supply and sanitation, estimated from the basin and hinterland population of 28 million, is about 3340 million cubic metres per year or 80 m^3/s (average of 250 litres per capita per day). The majority of this water is used by the cities and municipalities of Blantyre, Bulawayo, Harare, Kitwe, Lilongwe, Lusaka, Ndola and Tete. Although surface water resources are the commonest sources of water supply systems, the majority of the population uses ground water sources through boreholes and wells.

2.3.2.2. Irrigation. It is estimated that some 200,000 hectares have been developed for irrigation and about 7 million hectares can be irrigated within the basin. The current water demand and commitments for irrigation requirements should range between 200 and 400 m^3/s at peak abstraction times. The smallholder farmers, private estates and public irrigation schemes irrigate cereals (mainly rice, wheat and maize), vegetables, sugar plantations and tea. Notable large irrigation fields with at least 10,000 hectares each, are sugar plantations in Malawi and

Zambia. These fields draw more than half of the annual irrigation water. Besides, the irrigation abstractions in Mozambique downstream of Cabora Bassa are likely going to increase as the country forges ahead with reconstruction and development programmes which may include reopening the irrigation districts of Tete and Zambezi Provinces.

2.3.2.3. Inter-basin transfer. A number of inter-basin water transfers from the Zambezi River to the southern regions of SADC, that include irrigation requirements, are being contemplated currently. Yet there are un-exploited irrigable tracks of land along the river, for example the Kafue flats, Gwembe and Lusito valleys near Lake Kariba and the lower Zambezi and Shire flood plains, that can be developed as viable irrigation schemes. It is ironical that the riparian states import grain from South Africa! There is a need, therefore, for better water demand management and rationalisation through strategic planning, economic pricing of water, substituting trade in food (not water), considering opportunity costs in water allocation and creating regional (not national) self sufficiency and security in food and electricity. This approach, accompanied by trade and industrial development liberalisation and freer movement of economic activities, products and services, would go a long way in reducing the local effects of growing water scarcity.

3. Water resources and environment and management practices

There is no doubt that water resource developments have improved the economy of the riparian states. However, the construction and operations of both the Kariba and Cabora Bassa dams have had environmental impacts. The legal agreements for the development of these dams did not address issues of environmental impacts. As a result, adverse impacts of the dams were not effectively mitigated.

The Kariba and Cabora Bassa reservoirs or lakes have stabilised the annual flow fluctuations, significantly attenuating the flood flows and raising minimum flows. However, the abrupt blockage of the river flow during the filling up of the reservoirs resulted in rapid attenuation of the discharge, with detrimental effects on the ecology and ecosystem downstream. For example the closure of Zambezi River flows during the filling up of the Cabora Bassa reservoir in 1974 resulted in the rapid and dangerous reduction of the discharge from 3200 plus to just less than 300 m^3/s within a few days. This rapid draw-down obviously caused significant environmental changes, including fish, in the lower Zambezi and Shire rivers.

The impounding of the waters in the Kariba reservoir covering a large area of 2400 km^2, impacted adversely on the riparian population, fauna and flora. The negative social and economic aspects of resettlements, loss of animals and relocation of those that survived vs the benefits of the Kariba complex are still controversial today among environmentalists and supporters of development.

The blockage of free passage, up and down the river, to migrating fish by dams, such as the two Kariba and Cabora Bassa dams, had environmental impacts as well. The flow regulations resulting from the reservoirs or lakes and requirements for hydropower generation have also altered the ecology and ecosystem of the wetlands downstream of the dams. For example, the Mana Pools downstream of Kariba are considered to have changed their ecological balance

and productivity, including fish. However, the creation of the two artificial lakes have undoubtedly increased fisheries development activities, particularly with the introduction of the exotic fish stocks like *kapenta*. Since then, the fishing business has become one of the major spin-offs from the construction of these dams.

3.1. Water resources degradation and pollution

Poverty, population pressure and poor land use practices have led to widespread catchment degradation, water resources degradation and pollution. As a consequence, there are some serious soil erosion and increased flash runoff problems, with rivers flooding more frequently and their hydrographs receding or drying faster than before.

The prevalent flash runoff diminishes groundwater recharge, increases sediment loads and sometimes induces excessive leaching of agrochemicals into streams and rivers. Efforts to deal with the land and associated water resources degradation and pollution problems are frustrated by the fact that the poor do not choose to degrade the environment. Their poverty does not give them any other choice than to grow food by whatever means, or indiscriminately fell trees or burn coal to sell for 'survival'. They can not even afford to invest in good land husbandry practices. Yet the degradation and pollution is not only an environmental loss but has an economic cost which someone has to pay directly or indirectly.

Further, there are incidences of domestic, trade, industrial and mining related pollution, including DDT and heavy metals, in the basin. Pollution, although confined within particular riparian states, is a serious problem in the Kafue River, around and immediately down-stream of the Kitwe and Kafue towns in Zambia, for example. Traces of DDT and heavy metals have been detected in Lake Kariba. Eutrophication is also becoming very common to the extent that river reaches, reservoirs and lakes are experiencing water weed problems throughout the basin. For example, Lake Chivero, that provides water supply to Harare City in Zimbabwe, has had serious problems with water weeds since 1991. The problems may get worse unless the nutrient levels are significantly reduced and effective measures for the control of water weeds at basin level are in place.

3.2. Droughts and water scarcity

The main challenge in the common management of the Zambezi River basin, is the sustainable water resources management that guarantees security in water supply and sanitation services, food and electricity supply from limited and vulnerable but considerably competed for water resources. It is equally important that other uses and water dependent services are also satisfied. Sustainable management is complicated by persistent droughts, extreme variation of the occurrence and distribution of water resources, high population growth, absolute poverty, desertification, and sometimes floods.

Unlike the hydrology of temperate regions, about 90% of runoff from the catchment areas and sub-tributaries occurs in less than six months of the year. This leads to general water scarcity in dry seasons. The persistent droughts have made seasonal variation in runoff quite severe in recent years. The high population growth and urbanisation rates are rapidly increasing water demand and subsequently amplifying the effects of droughts or floods. The

pressure of population and urbanisation have also aggravated water resources degradation or pollution. All of these have exacerbated the threats of water scarcity, challenges for equitable water resources allocation and environmental insecurity in the basin.

The persistent droughts, particularly during the 1980s and 1990s, have had significant adverse impacts in southern Africa. As a result, there are considerable challenges in strategic and sustainable planning and management of the basin's water resources. The dam of Lake Kariba has not spilled since 1982 and its hydropower plants cannot generate at full capacity resulting in power shortages, particularly in the 1990s. In Zimbabwe, droughts further caused severe water scarcity for municipal water supplies in cities like Harare and Bulawayo. In fact there are proposals to abstract water from the Zambezi River for greater Bulawayo water supply, as a mitigation measure against future recurrence of such droughts. In Malawi, water levels of Lake Malawi reached the lowest levels in 1995 since 1931. The phenomenon is raising fears that the situation may return to the 1915–1935 period when the lake was so low that the outflow into the Shire River ceased (Box 1).

In the future, the impact of drought will become worse than experienced in the 1990s as population, industrialisation, urbanisation and the need for expanded agriculture/irrigation, water supply and sanitation services, etc., continue to rapidly grow. These persistent and chronic droughts should, therefore, be considered as 'normal situation' in strategic planning and management of water resources rather than being emergency situations.

Box 1. Droughts and water scarcity amid floods in Zambezi River riparian states

The effects of drought on water scarcity in the basin states have been devastating. Equally important are the effects of occasional floods. The examples below illustrate these effects.

Zimbabwe. During the drought of 1991/1992, the country's agriculture production fell by 40% and 50% of its population had to be given relief food and emergency water supplies, through massive deep drilling programmes, since many rural boreholes and wells dried up. Urban water supplies were severely limited with unprecedented rationing. Electricity generation at Kariba fell by 15% causing severe load shedding. As a result its GDP fell by 11% (David Gray, Personal Communication).

Malawi. During 1978–1986 Lake Malawi levels were very high, causing severe flooding along the lake shore and Shire River. Tourists and permanent settlements and infrastructure were damaged and navigation facilities severely impaired. However, since 1990 the lake levels have been dropping and reached the lowest point in December 1995 since 1931! During the same period, the Shire River flows, although regulated, recorded its lowest discharge since 1955. As a result the berth at ports along the lake are very shallow and some cargo ships have been aground since 1992. The hydropower plants, waterworks for Blantyre city and irrigation abstractions for a 10,000 hectare sugar plantation have been severely hampered. Siltation at the Nkuwa Barrage has exacerbated problems. Removal of the silt and rehabilitation of the barrage will cost US $3 million.

Population dynamics and poverty have complicated water scarcity, water resources degradation and pollution. The basin has an estimated population of about 28 million with growth rates averaging 3%, and with densities as high as 240 per km^2 in some rural areas of Malawi. Some 20 million people, out of this 28 million, live under absolute poverty (SADC-ELMS, 1994). Population management may offer solutions to water scarcity problems. Relocation of the population and family planning issues may just be as relevant in water resources management and water scarcity mitigation as the identification and development of dam sites, reservoirs, water supply systems, etc.

4. Issues for shared management of the Zambezi River Basin

4.1. Existing agreements and joint water resources management schemes

The emerging water scarcity, degradation and pollution problems are trans-boundary and require common basic policy, legal and institutional arrangements. The internationalisation of water resources management started with the establishment of the Central African Power Company (CAPCO) in the 1950s, which later became Zambezi River Authority (ZRA), prompted by the need to develop hydropower potential along that part of the river common to Zambia and Zimbabwe. The need arose because the development of hydropower at Kariba required construction of a dam which would span across the river, taking up pieces of land in both countries. It also required joint development and management of those Zambezi River waters common to both countries. A number of legal agreements between Zambia and Zimbabwe or previous governments were prepared, negotiated and adopted. The last agreement culminated in the enactment of two identical Zambezi River Authority Acts of parliament in 1987, one for Zambia and the other for Zimbabwe.

The operations of the water resources improvements, too, have caused misunderstandings. The controversy caused by lake shore flooding around Lake Malawi during the early 1980s, can demonstrate this. Malawi was suspected of deliberately blocking the Shire River with the barrage at Liwonde to raise lake levels and inundate the shore areas, particularly in Tanzania. The misunderstandings were only cleared when hydrologists from Tanzania and Malawi jointly visited the mouth of and along Shire River in 1989. It was realised that the barrage would have been over topped if closed at high lake levels and that the extreme high rainfall in the catchment was the main cause of lake shore flooding.

Another example is the agreement between Malawi and Tanzania over the development of the Songwe River basin. This river drains into Lake Malawi and marks the border between the two countries. The Songwe River experience severe flooding and meandering in its 30-km very fertile and densely populated flood plain. These floods displace people every year and whenever a piece of land is cut off to the other side of the river the residents change nationality, as per a 1901 border agreement. The two governments reviewed the situation and adopted a plan in 1991, which calls for the joint stabilisation of the river that would involve construction of dams, levees and other accessory works necessary to canalise the flows in the flood plain. The project benefits will also include hydropower, irrigation, tourism, fisheries and environmental management.

On a basin scale, the riparian states[1] requested UNEP in 1985 to assist them put up the Zambezi River Basin Action Plan (ZACPLAN). The plan was expected to establish mechanisms for common management of the Zambezi River. The ZACPLAN project document agreement was eventually developed and adopted in 1987 by the riparian countries. It became a SADC programme in the same year. The Kingdom of Lesotho was given the responsibility of co-ordinating its implementation.

The ZACPLAN comprised 19 projects which were supposed to be completed by 1996 but only four have been financed and implemented. It is, however, unfortunate that none has been completed. The core project of the plan was 'The Development of an Integrated Water Management Plan'. This project has four components consisting of water resources data base development; sector studies, which would form the basis for water allocation among various water dependent or affecting sectors; development of an integrated water management plan; and implementation (initiation) of the plan. The data base development project was completed in Maseru in 1995 and the resulting operational database system was transferred from Lesotho to ZRA in Lusaka, in 1996. The sector studies are being implemented at ZRA, too. However, the future of the last phases are unclear. This is due to lack of decision on which institution to host their implementation. There is also lack of leadership in the finalisation of the project document, which was principally accepted in early 1995 for funding by Nordic countries.

4.2. Ground and surface water resources management issues

Ground water issues do not get much recognition, despite the wide use of boreholes and shallow wells as sources of water supplies, particularly in rural communities. Little is known about ground water movement, yields and recharge mechanisms. Compared to surface water resources, ground water data and information is very meagre at national and regional levels. Although there are chances of trans-boundary aquifers in the Kalahari sandstone and Katanga formations, no studies have been carried out to establish this and propose mechanisms for the efficient and sustainable management and utilisation of these groundwater bodies. Such studies may also shed light on the inter-relationship between surface and ground water systems in the region. The studies can also clarify whether the Okavango and Zambezi rivers are hydrologically one watercourse system.

It is also worth noting that the likelihood of ground water resources over-exploitation, degradation, pollution and reduced opportunities for recharge is not taken seriously. This is particularly a concern in urban areas, for example in Lusaka, and high populated rural communities where groundwater is used extensively. Mining activities, too, contribute to depletion of groundwater resources. Lack of ground water data and research make it difficult to manage ground water efficiently.

There have been lack of co-ordinated and strategic development, operation and utilisation of water resources improvements. This has tended to cause conflicts of interest among users and environment. In fact the floods in the Shire and lower Zambezi River occur almost every year,

[1] All riparian states participated in the initiation of the ZACPLAN except Angola and Namibia. Namibia, however, was represented by the UN, as it was not yet independent.

causing loss of lives, damage to property and render several thousands of people (from Malawi and Mozambique) homeless, without food and drinking water supply. These floods cost millions of US dollars in providing relief items to flood victims, repairing and rehabilitation of damaged infrastructures and properties. The existing Flood Warning System for Lower Shire, developed and operated by Malawi, is very limited despite its benefits both to Malawi and Mozambique. The flood control schemes, too, have not been developed in spite of their possibility and derived benefits. Besides, there are no operational arrangements to use the existing dams and barrages for flood control. Such schemes and their operational procedures can only be developed, implemented and operated jointly by and with full co-operation of involved or affected river basin states.

4.3. Prospects for common policy and legal agreement

One of the ZACPLAN projects was the establishment of a basin treaty for common management of Zambezi River. However, during the course of developing the basin treaty, it was decided by SADC to prepare and adopt a SADC Protocol on Shared Watercourse Systems instead. This Protocol, signed in 1995, is regarded as the pillar for setting up an enabling environment in equitable allocation and management of water resources in the shared basins within SADC. It recognises the SADC Treaty and its policy. It further calls for the establishment of a monitoring unit, river basin commissions, authorities and water boards for the implementation and enforcement of the provisions of the Protocol. Despite its signing by the SADC Summit in August 1995, the Protocol is not yet operational. It is awaiting ratification of the Protocol by riparian sates. There are, however, some countries with reservations against the provisions of the Protocol but these are not expected to prevent it from being ratified. The clauses can be amended as soon as the Protocol is operational.

The need for a dedicated agreement on the common management of the Zambezi River continues to be pursued by the riparian countries. A new basin agreement is under preparation. The progress is very slow because of problems with institutional arrangements that can effectively co-ordinate, facilitate and supervise the preparation of the agreement. The follow up of progress and supervision of the ZACPLAN programmes is considered weak as it relies on meetings of the Water Resources Technical Committee and higher SADC committees.

In fact the decision to assign the day to day responsibilities for the co-ordination and implementation of the ZACPLAN to SADC-ELMS in Maseru, in the first place, may not have been the best sustainable option. It meant giving these responsibilities to a country which is more than 1500 km away from the basin with no social and economic benefits and interest in the ZACPLAN. It appears the political will and commitment to follow the original ZACPLAN agreement, agreed by the riparian ministers in 1998, faded away. For example, the original plan of setting up a competent basin institution and capacity building inside the basin to be entrusted with day to day co-ordination and implementation of the ZACPLAN was not pursued. No institution and capacity building have been identified or established or developed for this purpose.

The political will, commitment and enthusiasm of the days when the programme was being initiated should have been encouraged by the donor support for some of the ZACPLAN projects. However, the riparian countries have not met to review the problems in the

programme implementation since 1987. As *stakeholders*, their meetings would have given the riparian countries the opportunities to seriously review themselves the ZACPLAN implementation and direct remedial measures for speeding up and completion of the projects. These negative developments should be reversed through ZACPLAN awareness campaigns that give details on the issues at stake, the objectives of the programme, its activities, outputs and how these would benefit stakeholders at national and regional level.

4.4. Lack of enabling environment for the Zambezi River common management

The lack of basin wide common policy, legal and institutional arrangements is obviously one of the main constraints in the management of the common Zambezi River. Despite the inception of ZACPLAN in 1987 and subsequent implementation of a few of its projects, no basin common policy, treaty or institution has been established to facilitate the ZACPLAN process as originally proposed. There is also lack of awareness of international water management issues, their importance and required capacity in the joint and integrated monitoring, assessment, planning, development, conservation and protection of water resources in the Zambezi River basin. Although there is likelihood of water related conflicts, there are no mechanisms for their settlement or management within the Zambezi River basin.

In conclusion, the above water resources management issues cannot be solved by one riparian country alone, as they are trans-boundary. The lack of reliable and adequate data is hindering effective and strategic planning and management of both surface and ground water resources and water related environmental management. The data collection programmes and data dissemination mechanisms in the riparian states are deficient and need attention (World Bank, 1991). The unco-ordinated and disintegrated water resources development and management schemes need consolidation to promote equitable allocation and sustainable development of water resources.

In the development of policy, legal and institutional arrangements, it must be noted that the institutional weaknesses have been blamed for the failures of water resources management programmes, including the slow progress in the implementation of ZACPLAN.[2] However, the socio-economic importance of the Zambezi River among its riparian states and the opportunities that exist within and in SADC, make it absolutely necessary to urgently and effectively address the remaining policy, legal and institutional capacity constraints.

5. Recommended reforms in the management of the Zambezi River basin

In line with the aspirations of SADC, the policies and strategies for the management of the Zambezi River basin should be converging towards economic integration with joint and cross border water resources investments between or among the riparian countries.

Within the agreed policy and legal framework, an agreement should specify the basic roles and responsibilities of each country and stakeholders in the water resources management

[2] UNEP 1993 and Nordic 1991 and 1995 evaluation mission reports on the implementation of ZACPLAN.

including the management of flow regulations, abstraction rates or water rights, water degradation and pollution control. It should also specify the rights and obligations of riparian states and basin institutions in the advancement of integrated and joint water resources management. The translation of the policy into a legal agreement should include defining institutional mechanisms for the implementation and fulfilment of the objectives of the policy, the SADC Protocol on Shared Watercourse systems and the ideals of SADC related to water resources management at basin level. There is no doubt that there should be a Zambezi River Commission or similar institution under the basin agreement. The question is how it should be constituted?

Fig. 1 shows a schematic diagram of the recommended institutional set up for Zambezi River Basin Commission and affiliate agencies, River Authorities and River Water Boards. Although the Commission is an overall basin institution, its structure should be lean and flexible but strong, through its linkages with river authorities and water boards. The linkages between these institutions should balance stakeholder interests and consolidate their participation in water resources management. The exact relationship and functioning of these basin institutions should be developed in detail during the drafting of the basin agreement. However, the relationship should be flexible enough to allow updating as dictated by the advancement of the co-operation, integration and economic development in the basin and SADC region.

The Commission would be responsible to all the riparian countries for the administration of the river basin agreement and executing basin wide operations mandated to it by the said agreement. Its functions should include promotion and support of the establishment of the river authorities (water resources development agencies). These should be responsible to the

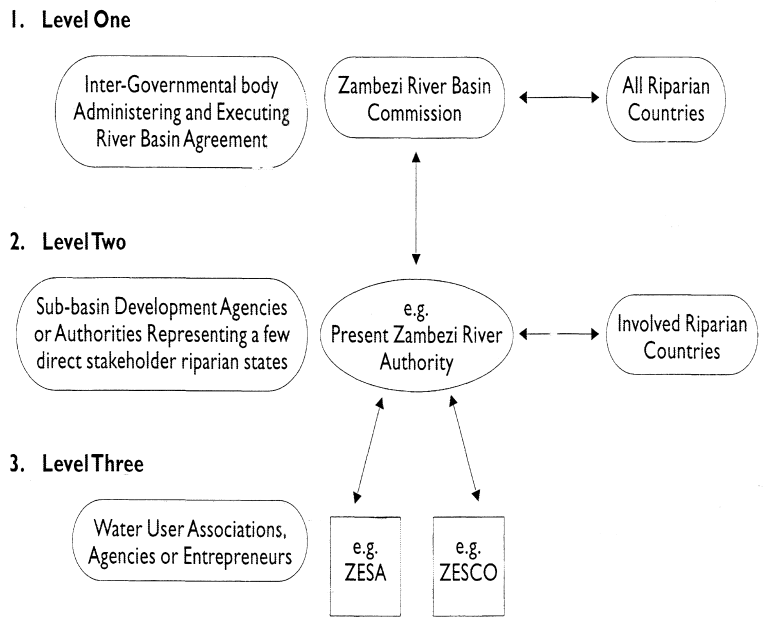


Fig. 1. Schematic diagram for SADC and Zambezi River basin institutions.

direct stakeholder riparian countries, for financing, planning, development and operation of the water resources improvements in a particular reach or sub-basin common to the countries involved. The river authorities should only be established for each sub-basin or reach that *has the demand or potential and economic viability for joint water resources developments and operations*.

For them to be effective, the river authorities should not be involved in the utilisation of the water resources improvements or their waters. This approach would facilitate their impartiality and effectiveness in the allocation and distribution of water and related services to Water Boards (user associations, agencies or entrepreneurs). The Water Boards may be for irrigation district boards that represent or serve several farmers, navigation boards (particularly for Lake Malawi, Shire River and lower Zambezi) or the power and water supply and sanitation boards or a combination. These boards may be for one or more countries who have agreed to work together in the utilisation of water resources improvements. The river authorities should promote and assist in the establishment of river water boards, with the full involvement of stakeholder agencies. The overall approach, therefore, can maximise demand driven stakeholder participation, strategic planning and development and equitable allocation of Zambezi River waters.

As an interim measure, it is strongly recommended that a Steering Committee of senior officials drawn from each riparian state and SADC Water Sector be set up as soon as possible. The Steering Committee should review, develop and manage the process of drafting and adoption of the detailed basin legal agreement and institutional structures proposed above. The recommended basin treaty should be presented to the *riparian countries* at an appropriate forum for negotiations and adoption. The agreement can be submitted to SADC and adopted as an annex to the SADC Protocol on Shared Watercourse Systems.

6. Common management of the Zambezi River

The Commission, through the executive branch, should co-ordinate and assist in the joint mobilisation of resources (financial, human and institutional) for the implementation of approved regional (basin) programmes and projects. The promotion of joint and cross border water resources development investments, following principles of equitable allocation and Dublin principles on water and sustainable development. This should include preparation and dissemination of cost sharing guide lines for joint projects. It should also promote the participation of all relevant stakeholders in water resources development, management and utilisation at both national and regional levels.

The executive branch, once established, should take over and lead the implementation of ZACPLAN, particularly the development and implementation of an agreed integrated water resources management plan for the entire basin. It should co-ordinate, establish and run unified and co-ordinated basin-wide water resources research, including that on appropriate development and management technology, the collection, processing, analysis and dissemination of surface and ground water resources data and information, drought and flood forecasts and warnings among riparian states, the river authorities and water utility boards, etc. The services of SADC–HYCOS, a project whose activities include for automatic data

collection, transmission and dissemination throughout the region, and the ZACBASE, a database developed under ZACPRO 6 of ZACPLAN, would be indispensable to the executing agency.

The existing ZACPLAN project entitled ZACPRO 6: Development of an Integrated Water Resources Development Plan for Zambezi River should be completed urgently. This is necessary for the provision of mechanisms for basin wide water resources database and data exchange, water resources monitoring and assessment and agreed development and management plans. The existing water resources database developed in Phase I of the ZACPRO 6 should be operationalised to allow periodic and timely data updating and dissemination to riparian countries. The SADC–HYCOS and upper Zambezi telemetry system in Zambia and Zimbabwe should be supplemented by new programmes to complete operationalisation of the adopted basin network of hydrometric and water quality monitoring stations used in ZACBASE. The joint monitoring and assessment, using the database, should provide the basis for equitable allocation, protection, conservation and utilisation of water resources in all riparian countries. These are required for sustainable, equitable and environmentally sound utilisation of the waters of the Zambezi River and are very important for conflict management emerging from competing demands on the water.

The management of the Zambezi River, particularly those aspects related to international water resources management, including conflict management, preparation, dissemination and publicising international water resources management issues and public awareness campaigns, should be co-ordinated and implemented by the Commission's executive branch or executing agency. The flow regulations and large reservoir and barrage operations, flood control, river flow forecasting and warning for floods and droughts or low flows should be directly co-ordinated by the branch.

References

Chenje, M., & Johnson, P. (1996). *Water in southern Africa*. Maseru/Harare: SADC/IUCN/SARDC.

SADC-ELMS (1994). *Proposed SADC policy and strategy for environment and sustainable development*. Maseru: SADC-ELMS.

Sir, Williams, Harclow, & Partners (1954). *The control and development of Lake Nyasa and the Shire River*. London: Sir Williams, Harclow and Partners.

Trolldalen, J. M. (1996). *Challenges in management of shared water basins — Zambezi River Basin in southern Africa and implementation of ZACPLAN*. Norway: Lobo Grafisk AS.

World Bank. (1991). *Sub-Saharan Africa Hydrological Assessment Project Report*. SSAHAP. Washington DC: World Bank.

ZESCO. (1991). Compendium of selected hydrometeorological data relevant to hydroelectric sector in Zambezi Basin. SADC AAA3.4 Project. ZESCO, Lusaka.

Further reading

Hall, W. A., & Dracup, J. A. (1979). *Water resources systems engineering*. New York: McGraw-Hill.

International Law Association (1991). *Draft articles on law on the non-navigational uses of international watercourses*. The Hague: International Law Association.

Loucks, D. P. et al. (1981). *Water resources systems planning and analysis*. Englewood Cliff, New Jersey: Prentice-Hall Inc.

Mekong Secretariat (1993). *Study on principles and criteria for allocation, use, conservation and development of international water resources*. Bangkok: Policy and Planning Division, Mekong Secretariat.

Scovati, T., & Treves, T. (1992). *World Treaties for the Protection of the Environment, Chapter Three: Convention on the Protection and Use of Trans-boundary Watercourses and International Lakes (Helsinki, 1992)*. Milan: Arti Grafiche Decembrio S.r.l.

Shela, O. N. (1996). *Hydrological forecasting for water resources management*. A report for World Meteorological Organisation, Geneva.

SADC (1992). *Declaration, treaty and protocol of southern African development community*. Gaborone: SADC Secretariat.

SADC-ELMS (1995). *Protocol on shared watercourse systems*. Maseru: SADC-ELMS.

SADC-ELMS. (1996). *Proceedings of the Workshop on The Development of an Integrated Water Resources Management Plan for the Zambezi River Basin, 2–6 May, Livingstone, Zambia, Maseru*.

WMO (1992). The Dublin Statement and the Report on International Conference on Water and the Environment. In *Development issues for the 21st Century, 26–31 January, Dublin*.

WMO/UNESCO .(1991). *Report on water resources assessment*. Progress in the Implementation of Mar del Plata Action Plan and Strategy for the 1990s. Geneva: WMO/UNESCO.

World Bank (1993). *Water resources management — a World Bank policy paper*. Washington, DC: World Bank.

World Bank (1994). *International river basin organisations in sub-Saharan Africa — a performance perspective, final draft*. Washington, DC: African Division.

World Bank (1995). *Directions in development — towards sustainable development for water resources management*. Washington, DC: World Bank.

World Bank (1996). *African water resources — challenges and opportunities for sustainable development*. Washington, DC: World Bank.

World Bank/U.N.D.P (1990). *Sub-Saharan Africa hydrological assessment reports*. Washington, DC: World Bank/UNDP.