THE HYDROPOLITICS OF SOUTHERN AFRICA: THE CASE OF THE ZAMBEZI RIVER BASIN AS AN AREA OF POTENTIAL CO-OPERATION BASED ON ALLAN'S CONCEPT OF 'VIRTUAL WATER'

by

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submitted in fulfilment of the requirements
for the degree of

MASTER OF ARTS

in the subject

INTERNATIONAL POLITICS

at the

UNIVERSITY OF SOUTH AFRICA

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APRIL 1998

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Summary

Southern Africa generally has an arid climate and many hydrologists are predicting an increase in water scarcity over time. This research seeks to understand the implications of this in socio-political terms. The study is cross-disciplinary, examining how policy interventions can be used to solve the problem caused by the interaction between hydrology and demography. The conclusion is that water scarcity is not the actual problem, but is perceived as the problem by policy-makers. Instead, water scarcity is the manifestation of the problem, with root causes being a combination of climate change, population growth and misallocation of water within the economy due to a desire for national self-sufficiency in agriculture. The solution lies in the trade of products with a high water content, also known as 'virtual water'. Research on this specific issue is called for by the White Paper on Water Policy for South Africa.

Key terms:

SADC; Virtual water; Policy making; Water stress; Water barrier; Water balance; Population growth; Refugee migration; Riparian conflict; Resource conflict; Aridity; Desiccation; Climate change; Regional integration; Regional trade; Inter-basin transfer; Sectoral water efficiency; White Paper on Water Policy for South Africa; Enmeshment; Catchment management; Helsinki Rules; Functional co-operation

Student number: **518-859-8**

I declare that, "**THE HYDROPOLITICS OF SOUTHERN AFRICA: THE CASE OF THE ZAMBEZI RIVER BASIN AS AN AREA OF POTENTIAL CO-OPERATION BASED ON ALLAN'S CONCEPT OF 'VIRTUAL WATER'**", is my own work and that all sources that I have used or quoted have been indicated and acknowledged by means of complete references.

.... 30/3/98 ....

SIGNATURE DATE

(Mr AR TURTON)

*"Rather than look upstream in anger,
we must start looking downstream with compassion"*

Minister Kader Asmal
Announcing the White Paper on Water Policy
for South Africa

International water resources, specifically *shared river systems*, shall be managed in a manner that optimises the benefits for all parties, in a spirit of mutual co-operation. *Allocations agreed for downstream countries shall be respected.*

Principle 11 of the White Paper on Water Policy for South Africa

ACKNOWLEDGEMENTS

I would like to acknowledge my indebtedness to the following persons, all of whom have been deeply inspirational to me during the preparation of this research.

My wife, Anna and two children, Rex and Melissa are sincerely thanked for their ongoing sacrifice and support. I was not the easiest person to live with while I was grappling with this research, especially when my computer crashed and I lost all of the data. Rex helped me recover my data and assisted subsequently with the overall management of my computer. His superior knowledge in this regard is willingly acknowledged. Anna drew the map of the Kasikili-Sedudu dispute, which is presented in Figure 17, as no maps were available from other sources. She also assisted with the tedious task of proof reading.

Mariana Daffue started the intellectual journey for me. Once I had become interested in the research area, she began ferreting out information from places that I never knew existed. It is largely through her efforts that I managed to gather the facts that are presented in this research.

Prof. Tony Allan of the School of Oriental and African Studies (SOAS) came next. I presented my crude ideas to him, initially engaging in e-mail correspondence. A productive exchange of ideas began and he helped me to start thinking about the broad problem in more specific terms. It all came together one day in the staff common room at SOAS, when he explained the concept of 'virtual water' to me. The penny had dropped! I left SOAS in a state of excitement, and sat under the huge plane trees in Russell Square, scribbling down the concepts given by Prof. Allan, linking previously loose ideas together. This became my research proposal that Prof. Allan later read and commented on.

Introduced to me by Prof. Allan, Mr. Terry Evans opened up his personal library to me. He unselfishly shared with me his entire lifelong experience as a hydrologist with considerable African experience. More importantly he helped me, a social scientist, to understand the basic hydrological concepts that are the starting point of this research.

I originally met Prof. Brian Davies at Victoria Falls, overlooking the Zambezi River. I was immediately struck by his keen scientific mind, but more importantly for me as a social scientist, by his pugnacious passion for river ecology. Of great interest to me, he was involved in the original studies of the Zambezi during the commissioning of Cahora Bassa. His passionate plea to heed the lessons from experience, especially when it comes to tinkering with the environment by means of IBTs and the folly of a purely supply sided management mentality, is reflected in this study.

I have known Dr. Annamarie Kriek since my undergraduate years. Her insatiable enthusiasm for her work has always served as an inspiration to me. She combines a natural *joie de vivre* with a keen scientific mind and for this I admire her. Her gentle yet firm guidance has helped to reign me in when I tended to move off at a tangent. Her advice has been invaluable and has always been heeded.

Dr. Dirk Kotzé became my co-promoter towards the end of the study. He diligently read my draft copy and systematically highlighted the weaknesses and problem areas. He forced me to radically re-think the approach that I was using and it is largely through his efforts that the final document is structured as it is. His guidance was gratefully received at a time when some of the problems that arise from a cross-disciplinary study began to emerge.

Dr. Mark Dent of the Computing Centre for Water Research (CCWR) at the University of Natal, was a great assistance in locating SWE data that was not forthcoming from other sources. He subsequently read my draft copy and supported my efforts at a time when the going got tough.

Mr. Hugo Maaren of the Water Research Commission (WRC) gave me a lot of assistance by circulating my original draft copy amongst a number of interested researchers. He also provided me with a platform from which to propagate the ideas that have emerged from this research and thereby test the feelings of other researchers within the water field. This willingness to embrace the social sciences into the domains that have traditionally been the home of hydrologists, biologists, chemists and engineers has served to encourage me further.

Mr. Alan Conley of the Department of Water Affairs is also gratefully acknowledged. His lateral thinking and incisive mind have always inspired me. I have run my ideas past him on a number of occasions. Where he has criticised my thinking, I have always gone away and re-thought the issue and in all cases his guidance has proved to be valid. Wisdom is the product of a life experience, and aspects of this are what Mr. Conley has shared with me.

Finally, the transformation that has been taking place within the Department of Water Affairs, which was finally encapsulated in the White Paper on Water Policy for South Africa, has truly provided the foundation for the cross-disciplinary nature of this research. The wisdom of Minister Kader Asmal in this regard is fully acknowledged, as the White Paper is largely the result of his leadership.

To these people I owe a deep debt of gratitude. I alone accept responsibility for the conclusions of my research however.

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ABBREVIATIONS

ANC is the abbreviation for the *African National Congress* of South Africa.

ANJCC is the acronym for the *Angolan-Namibian Joint Commission of Co-operation.*

BDF is the abbreviation for the *Botswana Defence Force.*

DTA is the abbreviation for the *Democratic Turnhalle Alliance* in Namibia.

ELMS is the abbreviation for the *Environmental and Land Management Sector* within SADC.

ENWC is the acronym for *Eastern National Water Carrier* in Namibia.

FAO is the acronym for the *United Nations Food and Agriculture Organisation.*

GDP is the abbreviation for *Gross Domestic Product* at factor cost.

GEAR is the abbreviation for the macroeconomic strategy of the South African Government and stands for *Growth, Employment and Redistribution.*

GNP is the abbreviation for *Gross National Product.*

HPRP is the abbreviation for *Hydrological / Population Risk Profile* of a country.

IBT is the abbreviation used for the *Inter-Basin Transfer* of water.

ICJ is the abbreviation for the *International Court of Justice.*

IMF is the abbreviation used for the *International Monetary Fund.*

JCA is the acronym for the *Joint Operating Authority.*

JCC is the acronym for the *Joint Commission of Co-operation.*

JIA is the acronym for the *Joint Irrigation Authority.*

JPTC is the official acronym for three separate bodies. These are the *Joint Permanent Technical Committee,* the *Joint Permanent Technical Commission* and the *Tripartite Permanent Technical Committee.*

JPTWC is the acronym for the *Joint Permanent Technical Water Commission.*

JPWC is the acronym for the *Joint Permanent Water Commission.*

KOBWA is the acronym for the *Komati Basin Water Authority.*

LBPTC is the acronym for the *Limpopo Basin Permanent Technical Committee.*

LHDA is the acronym for the *Lesotho Highlands Development Authority.*

LHWP is the acronym for the *Lesotho Highlands Water Project.*

MAP is the abbreviation for *Mean Annual Precipitation.*

NDF is the abbreviation for *Namibian Defence Force.*

OKACOM is the acronym for the *Permanent Okavango River Basin Water Commission.*

PAC is the abbreviation for the *Pan Africanist Congress* of South Africa.

PCC is the acronym for the *Permanent Commission of Co-operation.*

PJCC is the acronym for the *Permanent Joint Commission of Co-operation.*

PJTC is the acronym for the *Permanent Joint Technical Commission.*

SACP is the abbreviation for the *South African Communist Party.*

SADC is the acronym for the *Southern African Development Community.*

SADCC is the acronym for the *Southern African Development Co-ordination Conference*, the forerunner of SADC.

SARCCUS is the acronym for the *Southern African Regional Commission for the Conservation and Utilisation of the Soil.*

SIDA is the acronym for the *Swedish International Development Agency.*

SWE is the abbreviation for the *Sectoral Water Efficiency* of a given economic sector.

TCTA is the acronym for the *Trans-Caledon Tunnel Authority.*

WBS is the abbreviation for *Water Barrier Scale* as conceptualised by Falkenmark.

WSI is the abbreviation for *Water Scarcity Index* as conceptualised by Falkenmark.

ZRA is the acronym for the *Zambezi River Authority.*

INTRODUCTION

THE PROBLEM AND ITS SETTING

Background to the Problem

Various hydrologists have predicted that a severe water scarcity is approaching in the first quarter of the twenty first century, which will allegedly be felt specifically in Africa. The most notable of these is Prof. Malin Falkenmark (1986b:192-200; 1987:191-200; 1989:112-118). In terms of these predictions, large parts of Southern Africa will be severely affected. The South African White Paper on Water Policy recognises this (DWAF, 1997:2.2.2). Most studies in the fields of political science or international politics tackle this type of problem by choosing as a point of departure, a study of the relevant water related policies that each state or international regional institution may have. This could become a parallel study in a regional context. This is felt by the author to be too limiting in scope however. Instead, what this study attempts, is to accept as a point of departure, the predictions made by hydrologists, that there will be an increasing water scarcity in the early part of the next century. To this end the work of Falkenmark (1989) is the origin of this intellectual journey. The study is based on the logic that, if the hydrological predictions of Falkenmark are correct, what will the likely impact be in terms of international politics within the Southern African region? In other words, this study deliberately tries to view the problem from an alternative point of departure, namely from studies conducted within the field of hydrology, and then tries to identify where policy interventions could be made in order to avert the disaster that the hydrologists are predicting. The deliberate intention is to introduce a hydrologically defined problem into the field normally studied by political scientists. By design then, this study is cross-disciplinary in nature, which implies that certain methodological problems inevitably manifest themselves. This cross-disciplinary approach is consistent with the White Paper on Water Policy (DWAF, 1997:7.1.2; 7.4.1). While it is acknowledged that statistics are not the only potential source of information, for this study they will become the absolute foundation. This is done deliberately in order to provide scope for a later evaluation of current state water policies against the findings of this research.

The Statement of the Problem

This research proposes to identify and evaluate the potential for functional co-operation that is likely to emerge between the riparian states of the Zambezi River Basin and South Africa in the post-apartheid era as a result of the projected increasing water scarcity, population growth, agricultural capacity and spatial unevenness which exists in terms of industrial development. The study also proposes to evaluate the potential that 'virtual water', as conceptualised by Prof. J.A. Allan of the School of Oriental and African Studies at the University of London, has as a development strategy that could be used as a means for interstate co-operation. Although it is not a Zambezi River riparian, South Africa is included in the study, as it is reaching a point where strategic access to water may have a negative impact on future economic growth. Decision-makers in South Africa may thus seek to meet this projected water shortfall from sources outside the borders of that country, with the Zambezi Basin being one possible option.

The Subproblems

The first subproblem. The first subproblem is to determine the full magnitude of the projected increasing water scarcity that is likely to be experienced within the Zambezi Basin states and South Africa in the first quarter of the twenty first century.

The second subproblem. The second subproblem is to determine the probable population growth patterns within the Zambezi Basin states and South Africa that are likely to exacerbate the impact of the first subproblem during the same time frame.

The third subproblem. The third subproblem is to examine the implications of the agricultural Sectoral Water Efficiency of the Zambezi Basin states and South Africa during the same time frame, in order to gauge the magnitude of the potential advantage of 'virtual water'. This measures the water consumption of the Agricultural Sector, expressed as a percentage of total national water consumption, against the contribution of the Agricultural Sector to the overall GDP of the economy. The resultant data enables an assessment to be made of the relative impact on the Agricultural Sector on both the overall economy and water balance of the state in question. The concept of Sectoral Water Efficiency is defined on page 7.

The fourth subproblem. The fourth subproblem is to examine the implications of the industrial Sectoral Water Efficiency of the Zambezi Basin states and South Africa during the same time frame, in order the gauge the magnitude of the potential advantage of 'virtual water'. This measures the water consumption of the Industrial Sector, expressed as a percentage of total national water consumption, against the contribution of the Industrial Sector to the overall GDP of the economy. The resultant data enables an assessment to be made of the relative impact on the Industrial Sector on both the overall economy and water balance of the state in question. The concept of Sectoral Water Efficiency is defined on page 7.

The Hypotheses

The first hypothesis. Water scarcity within the study area is likely to cause joint functional co-operation in the development of the shared water resources that exist between all Zambezi Basin riparian states and South Africa.

The second hypothesis. Functional co-operation in the study area in common issue-areas such as population growth and migration, agricultural capacity and spatial development, is correlated to functional co-operation in shared water resource management.

The third hypothesis. Reliance on a national policy for food self-sufficiency does correlate to a low Sectoral Water Efficiency for agriculture in the majority of the states in the study area.

The fourth hypothesis. Under inherently arid conditions in which the Sectoral Water Efficiency for industry is higher than that of agriculture, a 'virtual water' based policy would manage the water scarcity problems, and achieve economic growth and diversification.

The Assumptions

The first assumption. The first assumption is that in a region that has a history of political divisions and tensions, a possible way to gain co-operation between states is to avoid areas that could be described as 'high politics' and concentrate rather on areas where all states have common problems such as water scarcity. In Southern Africa it is assumed that while there are certain instances where water has been politicised locally, and even to a limited extent internationally as evidenced by the Kasikili-Sedudu dispute, water scarcity has not yet become an area of 'high politics' to the same degree evident in the Jordan River Basin. This could change in future as regional water scarcity increases.

The second assumption. The second assumption is that the Protocol on Shared Watercourse Systems in the Southern African Development Community (SADC) Region is a possible starting point for the envisaged co-operation, as this legal instrument already exists. There is also an existing sector (ELMS) within SADC currently based in Lesotho that is responsible for water. The assumption is therefore that both structures and instruments exist, albeit in embryonic form, which can form a basis of potential regional co-operation.

The third assumption. The third assumption is that the location of industrial growth centres is *not* a serious problem in relation to water distribution, as industry has a better 'return to water' than agriculture, and existing technology seems capable of supplying industrial water needs in the future. This assumption is strengthened if existing water supplies that are currently inefficiently tied up in marginal agriculture become available in future.

The Delimitations

The study will not attempt to determine if SADC is the most ideal international regional institution to promote co-operation within Southern Africa.

The study will not attempt to analyse SADC as a regional structure, but will rather focus on the issue-areas related to water that an international regional institution is likely to encounter in the first quarter of the twenty first century.

The study will not attempt an evaluation of the International Law aspects, and will accept the Helsinki Rules on Uses of the Waters of International Rivers and the work of the International Law Commission on the Non-Navigational Uses of International Watercourses, as stipulated in the preamble of the Protocol on Shared Watercourse Systems in the Southern African Development Community (SADC) Region. The reasons why these two international agreements are accepted without question are that firstly, the legal intricacies of each are beyond the scope of this study, and secondly because they both form the cornerstone of the international legal system regarding water. This is evidenced by them being accepted in the SADC Protocol on water. Thirdly, the White Paper on Water Policy stipulates the Helsinki Rules as being the basis of South African policy (DWAF, 1997:3.2) and gives active support for the additional development of a legal system (DWAF, 1997:6.9.2) that utilises the basis of equitable use (as enshrined in the Helsinki Rules).

The study will not attempt to evaluate the relative merits of the respective minor river basins geographically located within the Southern African region as focal points of joint co-operation. The criteria for selection for this study are the largest number of riparian states within a given international river basin that are also members of SADC. This implies that the Zambezi River Basin is the best focal point of regional co-operation as it complies with these criteria. The UN Register of International Rivers (1978b:6) lists eight states in this basin, all of which are members of SADC. Expressed in order of magnitude (of the portion of the basin that is shared) these states are as follows; Zambia (40,7%), Angola (18,3%), Zimbabwe (15,9%), Mozambique (11,4%), Malawi (7,7%), Botswana (2,8%), Tanzania (2.0%) and Namibia (1,2%). The Zaire (Congo) River Basin is physically larger however, with nine riparian states listed in the UN Register of International Rivers (1978b:5), but only four of which are SADC members. These are as follows; Democratic Republic of Congo (formerly Zaire), Angola, Zambia and Tanzania. This disqualifies the Zaire (Congo) Basin as the focus of this study.

The Definition of Terms

Agricultural Sector. For the purposes of determining the 'sectoral water efficiency' of the agricultural sector for this research, the 'agricultural sector' will consist of "agriculture", "hunting", "forestry" and "fishing" as the available statistics are structured in this way.

Aridity. Aridity is the climatic description of an area that expresses the relationship between precipitation and potential evapotranspiration (Arnestrand *et al.*, 1993:8) in which the naturally occurring precipitation is lower than the potential evapotranspiration demand (Arnestrand *et al.*, 1993:20). It is important to note that aridity is a natural phenomenon, unlike *desiccation*, which is anthropogenic in origin (Arnestrand *et al.*, 1993:14).

Cumec. A cumec is a measure of water flow equal to 1 m^3 / second (Dale, 1992:3).

Desiccation. Desiccation is a progressive drying up of the landscape, particularly the soil, resulting from anthropogenic factors such as deforestation and overgrazing (Arnestrand *et al.*, 1993:14).

Drought. Drought is a true meteorological occurrence involving irregular precipitation, which causes spells of exceptionally dry years (Arnestrand *et al.*, 1993:18).

Economic refugee. An economic refugee is a person that migrates from their area of birth due to a combination of push-factors such as local impoverishment, and pull-factors such as the perception that better economic conditions exist elsewhere.

Environmental refugee. An environmental refugee (sometimes referred to as an *ecological refugee*) is a person that migrates, frequently across an international border but not exclusively so, directly as the result of a loss of access to resource flows needed for the maintenance of livelihoods, due to environmental factors beyond their control.

Eutrophication. Eutrophication is the degradation of water resources, often manifesting itself in the form of prolific algae growth, as the result of high levels of phosphates and nitrates, which result from agricultural, industrial or domestic effluent.

Flow Unit. A flow unit is a conceptual unit that is defined as one million m^3 of water / year ($10^6 m^3 / yr^{-1}$) which is used to measure 'water stress' (Falkenmark, 1989:115; 1990:181).

Hydrological / Population Risk Profile. The hydrological / population risk profile is a useful tool to measure the impact of a known or projected population on the availability of water resources within the portion of the hydrological cycle that is available to that country. It is achieved by dividing the total or projected population by the volume of recoverable water resources expressed in 'flow units' ($10^6 m^3 / yr^{-1}$) which is interpreted in terms of the Water Barrier Scale and Water Scarcity Index.

Industrial Sector. For the purposes of determining the 'sectoral water efficiency' of the industrial sector for this research, the 'industrial sector' will consist of "mining", "manufacturing", "energy" (including petroleum where relevant) and "construction".

Inter-Basin Transfer. An inter-basin transfer (IBT) constitutes the transfer of water from one geographically distinct river catchment, or basin to another, or from one river reach to another (Davies *et al.*, 1993:161).

International Drainage Basin. An international drainage basin is an area within the territories of two or more states in which all the streams of flowing surface water, both natural and artificial, drain a common watershed, terminating in a common outlet or outlets, either to the sea, a lake or to some inland place, from which there is no apparent outlet to the sea (Maluwa, 1992:22).

Protracted Conflict. A protracted conflict is one, which involves high stakes, manifest as hostile interactions, which extend over long periods of time, with sporadic outbreaks of open warfare, fluctuating in both frequency and intensity.

Riparian Dispute. A riparian dispute is a dispute among two or more sovereign states over access to, or control over, the water resources of an international river basin that traverses their territories (Lowi, 1990:3).

Riparian Position. The riparian position refers to the physical location of a state within a given river system and hence the position that it adopts within the drainage basin vis-à-vis other riparian states. A high order position is one closer to the source of the river. In hydropolitical terms this is a strong position to be in as theoretically it implies that the state concerned can divert the water and withhold supplies from a lower order state. A low order position is one close to the mouth of the river. In hydropolitical terms this is a vulnerable position as both the water quality and quantity is determined by upstream higher order riparian states.

River Basin. A river basin is the area within which rainfall drains into a given stream; a catchment area (British usage) or watershed (US usage) (Westing, 1986:x).

Sectoral Water Efficiency. The sectoral water efficiency is the ratio of water consumed within a given economic sector (expressed as a percentage of total national water consumption) in relation to contribution of the same economic sector to overall GDP (expressed as a percentage of total GDP). (Sectoral Water Efficiency = Sectoral Water Consumption as % : Sectoral Contribution to GDP as %).

Sustainability. A development is seen as being sustainable when the current setting of socio-economic activities can continue indefinitely, or when current use of a natural resource does not impair possibilities for comparable future uses (Bannink, 1996:34).

Virtual Water. Virtual water is the volume of water needed to produce a commodity or service (Allan, 1996a). Allan (1996b) notes that it typically takes around 1 000 tonnes of water to grow one tonne of grain. This represents the 'virtual water' value of grain. 'Virtual water' is also present in hydroelectric power and constitutes the volume of water needed to produce a given unit of hydroelectricity.

Water Barrier. The water barrier is a conceptual unit that measures 'water stress', and is defined as 2 000 people / 'flow unit' of water, which is the maximum number of people that an advanced society is able to support and manage with currently available technologies (Falkenmark, 1990:181).

Water Barrier Scale. The water barrier scale is a measurement of water competition between the number of people that rely on one 'flow unit' of water represented on a linear scale of 1 - 5 (Falkenmark, 1989:116; 1990:182).

Water Scarcity Index. The water scarcity index is a conceptual tool developed by Falkenmark (1989:116), which consists of a two digit code that is used to introduce a variable element of agricultural development and thus take into account the higher requirements of water and technology inputs needed to maintain self-sufficiency in arid climates (Evans, 1995:2.8). The first digit refers to the level of technological input needed to maintain self-sufficiency, designated in terms of a linear position 1 - 4. The second digit corresponds to the Water Barrier Scale position as defined above on a linear scale of 1 - 5.

Water Stress. Water stress is a conceptual measurement defined in terms of the number of people / 'flow unit' of water. Arid zone figures indicate that a measurement beyond 500 persons / 'flow unit' may be considered as 'water stressed' (Falkenmark, 1989:115).

The Importance of the Study

Prof. Barry Buzan is a leading scholar in broadening the meaning of security matters within the field of international politics. He notes that the state has three component parts. These are the "idea" of the state, the "physical base" of the state and the "institutional expression" of the state (Buzan, 1991:65). This is illustrated in Figure 1. Significantly, the physical base of the state is also the area in which states share the most similarities in relation to security (Buzan, 1991:91). As the threats to the physical base of the state are common in all types of states, due to the similarity in the physical objects involved (Buzan, 1991:91), such threats can form the logical focus of inter-state co-operation. Water is clearly within the scope of Buzan's thinking as it is a fundamentally important natural resource that forms part of the "physical base" of the state.

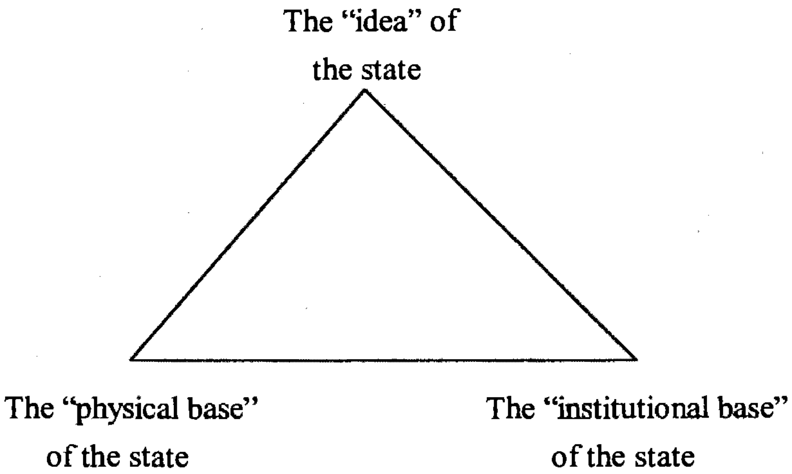


Figure 1. The component parts of the state as conceptualised by Buzan (1991:65).

Attention to security aspects of water issues in Southern Africa so far has been concentrated on the risk of water transfer schemes (IBTs) creating conflicts - political or ultimately violent - between states in the region. The mere perception of such risks is a security threat in its own right however, undermining the confidence creating measures between countries (Ohlsson, 1995a:i). Water scarcity thus is defined as a threat, not first and foremost to international peace within the Southern African context, but to the ability of developing countries to pursue a successful social development policy, as a result of challenges to the state, due in turn to a combination of population increase, scarcity of land and water resources (Ohlsson, 1995a:6). Water scarcity has in fact been identified as potentially the greatest future cause of conflict in the SADC region (Ohlsson, 1995a:1) with the states of semi-arid Southern Africa being warned to prepare for intensified competition over water (Hudson, 1996:8) in the near future. Water and politics thus become linked in arid regions, sometimes to the point where "states that are adversaries in 'high politics' of war and diplomacy do not allow extensive collaboration in the sphere of 'low politics' centred around economics and welfare" (Lowi, 1990: 375) as has happened in the Middle East. Where this happens, Lowi (1990: 7; 375) notes that 'spill-over' as suggested by Mitrany as an integral dynamic within a Functionalist co-operation model, actually runs in the opposite direction; economic and welfare co-operation become retarded by 'high politics' conflicts between the states in a region and water related conflict can become a 'high politics' issue.

Historically within Southern Africa there has been limited co-operation in the form of intra-regional trade within the former SADCC, with past activities tending to centre on the co-ordination of anti-apartheid strategies of Member States prior to 1992. What SADC, (the treaty based trans-national grouping which emerged from SADCC in 1992), *has* achieved however is the establishment of a regionally based structure that has become recognised by the major international Donor Community. Ohlsson (1995a:16) adds to this by stating that,

> "no single factor has changed prospects for regional SADC co-operation on integrated water resource management more than the advent of the 'new' South Africa. The main negative *raison d'être* for SADC's existence so far, has now become the organisation's most powerful and competent member, bringing both hope and certain fears with it".

SADC is committed to making "economic integration a reality through mutually beneficial co-operation" (Business Day, 31/8/95), but the principle international issue in water resource management is the lack of river basin authorities in the region (SADC, undated:11/34). The post-apartheid era has heralded in a new stimulus to co-operate at a regional level, significantly with the Protocol on Shared Watercourse Systems in the Southern African Development Community (SADC) Region being the first protocol in the SADC structure to be finalised (Solomon, 1996:2). This is considered to be the most important aspect from the point of view of co-operative policy making and management of international freshwater resources in the region (Bannink, 1996:32) and is likely to form the foundation of any future co-operative agreements between the Zambezi Basin states and South Africa.

Ohlsson (1995b:4) supports the case made by Falkenmark (1990) that no successful industrial nation came forward during the initial industrialising phase in areas where water was not relatively abundant. The only exceptions noted are the case of South Africa and Australia, but it is stressed that in these cases industrialisation was confined to small enclaves of relative water abundance within otherwise arid areas. This again illustrates the important role that South Africa can play within the context of a region that is developing.

The fact that the region is facing an increasing water scarcity problem is already evident and is further elucidated in this research. This scarcity is the result of a complex interaction of events such as global warming, population growth rates, environmental degradation and poor agricultural practices. In the short-term, the strategy that has been adopted by states within the region is to concentrate efforts to supply more water, exploiting existing sources more heavily and thus bringing the problem of shared water resources into focus more clearly. This is the so-called 'supply side management' or mentality that is alluded to further during the research. This implies that existing competition between different segments of society which are already apparent - agriculture vs. industry, and rural vs. urban - will bring new risks of conflicts of interest to the fore, (Ohlsson, 1995a: 9) possibly on the inter-state level. As Allan notes (1994:85) "the problem lies in the politics" of water. The simple fact is that the water scarcity is projected to increase, and that any sustainable solution is likely to be beyond the capacity of any one single state to effectively implement. This implies that a new approach to the problem is needed. This is the so-called 'demand side management' or mentality that is alluded to further during this research. International co-operation based on functional issues such as shared water scarcity problems thus offers a unique opportunity for international regional institutions such as SADC to gain a renewed *raison d'être*.

As Lowi (1990:8) notes, there are two factors that will induce states to minimise the salience of inter-state conflict for the shared water issue-area. These are:

- Firstly, states which have considerable need for the water resources in question and/or are heavily dependent on the basin waters, will be motivated to co-operate with some or all of the riparian states, especially when access to the water is linked to the security concerns of the state insofar as it is a necessary element of national survival.

- Secondly, if the dominant power in the basin will benefit from regional co-operation in water utilisation, it will take the lead in creating and maintaining a regime, and will enforce compliance to its rules.

This study shows that both of these conditions exist within the Southern African region, with South Africa being the dominant power that has considerable need for access to reliable new water sources that originate outside its own borders. Ohlsson (1995a:16) expands on this by stating that South Africa provides a completely different picture from the rest of the SADC Member States, regarding both capacity and competence. To this end it is noted that South Africa has an "extremely well developed" water resources planning and management sector, and hopes are high (among the international community) that this competence will be utilised in a regional context. South Africa, in her capacity as a member of SADC, can thus play a major role as catalyst for regional co-operation, in this case within the Zambezi Basin.

The problem is that it typically takes twenty-five years for new ideas to be incorporated into effective government strategy (Allan, 1996b; 1996e). During this period the problem is likely to escalate into unmanageable proportions with some populations *doubling* in that time. Ohlsson (1995a:9) calls for a possible restructuring of the agricultural and industrial sectors in an attempt to move away from the conflict-generating strategies of increasing water supply alone ('supply side management'). By making a policy shift away from favouring traditional uses of water for marginal agriculture, based on the paradigm of national self-sufficiency, where the 'returns to water' are low, to an industrially based regional political-economy that is more spatially balanced, where the 'returns to water' are higher, the increased wealth generated can allow for the importation of 'virtual water' inherent in heavily subsidised cereals readily available on the international market. Evidence from the Middle East for this is presented in the study.

There are similarities in the Middle East case study presented later with Southern Africa. In the case of Southern Africa, states such as South Africa and Botswana are reaching the limit of their natural surface water resources and are thus beginning to realise that alternative policies will be necessary to ensure future survival. The transition from pure 'supply side management' to a more complex 'demand side' approach is thus underway. For example, Botswana has recognised that there is insufficient water for irrigation and has made a policy shift away from self-sufficiency in food, to a policy of 'food security', that is based on a strong and diversified economy (Arnestrand *et al.*, 1993:31). This has already resulted in Botswana being able to effectively combat the effects of the 1983-87 drought that devastated neighbouring Zimbabwe (Arnestrand *et al.*, 1993:33), which significantly still persists in the adherence to a policy of agricultural self-sufficiency and 'supply side management'. This transition is also evidenced in South Africa and is recognised in the White Paper on Water Policy (DWAF, 1997:6.4; 6.5). Freed finally from the need for national agricultural self-sufficiency that the period of apartheid-induced isolation imposed, South Africa can now increasingly satisfy its needs for agricultural products from the open market, while beginning to contemplate a better utilisation of its diminishing water resources (Conley, 1996c:19). Two of the economically stronger states in Southern Africa are thus naturally moving in a direction similar to that of Israel already, albeit driven by own national interest rather than as part of a deliberate regional policy at this time.

Lowi (1990: 373-4) found that regional political conflict exacerbates the water-related problems of states in arid regions by preventing the resolution of riparian disputes. Within the Zambezi Basin in the post-apartheid era, there has been a significant reduction in international tensions and the general 'normalisation' of inter-state political interaction, with no evidence of the existence as a 'core value' of one state questioning the fundamental legitimacy of any other state. The case study of the Kasikili-Sedudu Island dispute illustrates this point. Differences do exist between the Middle East and Southern African hydropolitics however, as the water related shortages are not yet at a level where they can threaten the existence of any one state in Southern Africa. Unlike the case of the Jordan River Basin, there is no 'core value' in existence that questions the legitimacy of any one state, or the right of such a state to exist, as has been the past experience of Israel. To this end, even though both King Hussein and President Anwar Sadat have acknowledged that Israel has the right to exist, notably after the Camp David Accords, there are other key actors in the Arab-Israeli conflict that have at times vehemently propagated this view. It can thus be said that there was a 'core value' regarding legitimacy at some stage in that conflict.

'Virtual water', as a new concept, thus deserves to be evaluated in terms of its potential to solve the regional water shortages that are projected to occur within the Zambezi Basin states and South Africa in the early part of the twenty first century.

Research Design and Methodology

This study attempts to examine some of the political implications of the increased water scarcity within Southern Africa that hydrologists such as Falkenmark (1989) predict. The original point of departure is thus not from within the known parameters of the discipline of political science. Therefore no single theoretical model presented itself from the literature as being completely adequate, given the fact that all existing political science research tends to focus on actual case studies of water related conflict, each with their own unique set of causes and effects. This is consistent with Lowi's (1990:22) findings that "any single approach is limited in its explanatory value because it ignores other, equally important variables".

In the opinion of the author, none of the existing dynamics present in Southern Africa match those found elsewhere to such an extent as to warrant the application of one given methodology used in research done in other regional settings. In Southern Africa there is a conflict potential which has not yet escalated to any significant extent. Therefore this research will be guided by a combination of approaches. Lowi's

(1990:23) Theory of Hegemonic Co-operation is used to explain why South Africa and Zimbabwe are likely to play a dominant role in Zambezi Basin hydropolitics. Lowi's (1990:11-12) framework of variables that have been of primary concern to states in the Jordan Basin is used where considered to be relevant. In addition to this, the research is guided by the concept of 'virtual water' that is being developed by Prof. J.A. Allan of the School of Oriental and African Studies (SOAS) at the University of London, and with whom the author is in regular contact. Significantly, the underlying principles of 'virtual water' are enshrined in the White Paper on Water Policy (DWAF, 1997: 2.2.1; 4.1.4; 4.2.1; 5.1.2; 6.5.2; 6.6.2) (but are not referred to by using the exact term 'virtual water') and are even defended as being "constitutionally valid" (DWAF, 1997:2.1.8). In addition to these concepts, the water scarcity indicators developed by Prof. M. Falkenmark of Linköping University, Sweden will also be used. These indicators are also enshrined in the White Paper on Water Policy (DWAF, 1997:2.2.2; 3.1).

This methodology is represented as a flow chart in Appendix "A". The methodology requires the establishment of the magnitude of the 'water scarcity' in order to determine the population growth component of that scarcity. This provides the hydrological origin of the problem being studied. This poses an epistemological problem for the research however, as there is generally a paucity of statistical data from Africa, regarding both population figures and the volume of recoverable resources available. It therefore comes down to a rational choice of either abandoning the research as being logically impossible to conduct given the paucity of data available, or accepting that the statistical basis is derived from the best available data, knowing that this data may be incomplete. The author took the latter option after consultation with hydrologists who concurred with the viewpoint being expressed. In fact, representatives of both the South African Department of Water Affairs and Forestry and the Development Bank of Southern Africa, went so far as to suggest that a deliberate initiative should be launched, possibly under the auspices of SADC, to improve the statistical database currently available to policy makers, researchers and planners active in the water field.

For this reason it is assumed that in the absence of accurate data on the actual volume of recoverable water resources from each Zambezi Basin state, and considering the variability of these local data sets where available, the data used by Prof. M. Falkenmark (1989:113) and which is generally acceptable to most hydrological consultants active in the Southern African region (MacDonald *et al.*, 1990a:2.5-2.28; Evans, 1995:2.8), will be used in all computations. The data provided by Ohlsson (1995a:48) will be used for South Africa as Falkenmark has ignored that state, but the rest of Ohlsson's data correlates with that of Falkenmark. Whilst other data does exist for South Africa specifically, it will not be used simply to ensure that methodologically "apples" are being compared with "apples" by systematically using data from a similar origin. This is consistent with the approach that is the original point of departure for this study, as stipulated in the background to the problem at the start of this introduction, that Falkenmark's projections are accepted as a given with the subsequent research emphasis being rather on the implications.

For the same reason it is assumed that in the absence of accurate data on the actual population growth of each Zambezi Basin state, the data as provided by the FAO and used by Falkenmark (1989:113) and SADC hydrological consultants (MacDonald *et al.*, 1990a:2.28) will be used in all computations. The data from Arnestrand *et al.*, (1993:24) and Ohlsson (1995a:48) will be used for South Africa in order to minimise variations and to enable more accurate comparisons to be made as the rest of the data quoted by these two workers correlates to that of Falkenmark, who unfortunately ignores South Africa. While it is acknowledged that at least in the case of South Africa, more accurate data is available, it will not be used simply to ensure that methodologically "apples" are being compared with "apples" by systematically using data from a similar origin. This is consistent with the approach that is the original point of departure for this study, as stipulated in the background to the problem at the start of this introduction, that Falkenmark's projections are accepted as a given with the subsequent research emphasis being rather on the implications.

The combination of the data relating to the volume of recoverable resources and projected population growth is expressed in terms of the WBS, as conceptualised by Falkenmark. The WBS is then placed on Falkenmark's WSI Matrix which links the level of 'water competition' in each riparian state to the 'level of technology needed' to attain self-sufficiency. This results in a two-digit code known as the WSI. The WSI is then used to determine a 'hydrological / population risk profile' (HPRP) of each Zambezi Basin state and South Africa. Given the fact that no prior study in the field of international politics has used this hydrologically derived data, and therefore no guidelines exist, the norms have been arbitrarily defined. The results of this HPRP will be interpreted as follows:

- 11 & 12 is a low HPRP
- 21, 22 & 31 is a medium HPRP
- 13, 23, 24 & 32 is a high HPRP
- 25, 33, 34 & 44 is a very high HPRP

This is further refined by calculating the agricultural 'sectoral water consumption' expressed as a function of 'sectoral contribution to GDP' where known. This gives an empirically based indicator of agricultural SWE for each Zambezi Basin state and South Africa. Given the fact that no prior study in the field of international politics has used this hydrologically derived data, and therefore no guidelines exist, the norms have been arbitrarily defined. Interpretation of the agricultural SWE will focus on the consumption side of the equation and will be done as follows:

- If <50% of the consumption contributes up to 50% of the GDP it is regarded as relatively high efficiency
- If 50%-75% of the consumption contributes up to 50% of the GDP it is regarded as medium efficiency
- If >75% of the consumption produces up to 50% of the GDP it is regarded as relatively low efficiency

The industrial sector is then analysed in the same way by comparing industrial 'sectoral water consumption' expressed as a function of 'sectoral contribution to GDP' where known. This gives an empirically based indicator of industrial SWE for each Zambezi Basin state and South Africa. Given the fact that no prior study in the field of international politics has used this hydrologically derived data, and therefore no guidelines exist, the norms have been arbitrarily defined. Interpretation of the industrial SWE will focus on the contribution to the GDP side of the equation and will be done as follows:

- 0-25% of the contribution to GDP is regarded as relatively low efficiency
- 26-50% of the contribution to the GDP is regarded as medium efficiency
- >50% of the contribution to the GDP is regarded as relatively high efficiency

Where 'sectoral water consumption' data are not available, other less refined indicators are used such as 'sectoral employment', or 'sectoral contribution to GDP' alone. This results in an empirically inconclusive outcome however and is only used as a last resort. This 'relative efficiency' enables the 'virtual water' potential to be quantified. The relative efficiency cannot be seen in absolute terms however, as these criteria are still in need of additional refinement.

Lowi's (1990:11-2) framework of variables is then used to determine the resultant political dynamics that are likely to emerge between the Zambezi Basin states and South Africa. Three variables are considered to be important and are used. These are:

- Resource (water) need / dependence
- '*Rapport de Forces*' / relative power position in the basin
- Character of riparian relations

This analysis leads into a discussion on the probable hydropolitical dynamics that are likely to result from the HPRP and SWE analysis. Where applicable case studies are used.

Structure of the Study

Chapter 1 consists of a review of the related literature. A dilemma involving Realism versus Idealism is highlighted in order to make the reader aware of the issue. Given the fact that the reader is likely to be a political scientist rather than a hydrologist, key hydrological concepts such as the water cycle, WSI and WBS are introduced. Specific attention is given to the three theoretical frameworks that form the basis of the study. These are:

- Lowi's theory of hegemonic co-operation
- Allan's concept of 'virtual water' and the significance of SWE
- Falkenmark's WSI, WBS and water (hydrological) cycle

In Chapter 2 the general literature related to the four subproblems is presented and discussed. The Realism versus Idealism dilemma is expanded upon with reference to another issue that is causally linked to this - that of approach. In this case the issue revolves around State Centrism versus Regionalism. Chapter 2 uses a general comparative approach under the auspices of each subproblem, as this is the most appropriate choice at the time. This serves to provide an indication of general trends. The four subproblems are integrated at this point.

The individual Zambezi Basin states and South Africa are then analysed in Chapter 3 in terms of the research methodology flow chart presented as Appendix "A". This represents a shift from a general comparative (regionalist) approach, to a more detailed analysis of each individual state. This results in a hydrologically derived empirical quantification of the problem, which in turn enables the origin of the hydropolitical dynamics to be accurately determined.

The case study of the Kasikili-Sedudu Island dispute is presented and analysed in Chapter 4, along with other relevant cases involving riparian related disputes. Specific attention is given to the 'core values' that are evident in the resolution of the conflict. These conflicts provide an opportunity for determining an empirically derived opinion regarding the behaviour of certain states within the study area. This in turn gives an indication as to the value placed on legal instruments as opposed to armed confrontation for the resolution of riparian related disputes. An indication as to the way that states actually behave sheds some additional light on the Realism versus Idealism dilemma. This is necessary in order to determine if there is any potential to the conflict that may ultimately impact negatively on regional co-operation.

The hydropolitical dynamics that are likely to emerge between the Zambezi Basin states and South Africa are discussed in Chapter 5. This is based largely on the conclusions drawn from Chapters 3 and 4, and allows states with common hydropolitical characteristics to be grouped for the first time. This chapter seeks to strike a balance between the comparative approach used in Chapter 2 and the individual state approach used in Chapter 3.

The study is concluded in Chapter 6 by referring back to the original hypotheses. Suggestions for additional research are made where relevant. Comments are made regarding the impact of the arbitrary nature of the criteria used to categorise the HPRP and SWE. The study is ended with a bibliography.

CHAPTER 1

REVIEW OF THE THEORETICAL ASPECTS OF THE STUDY

A General Overview

Rivers play an important role in demarcating territorial borders, but their watersheds and catchments frequently fall under the sovereign control of potentially hostile neighbours. International watercourses fall into two general categories; *contiguous* or *boundary* watercourses that flow between two or more states, and *successive* watercourses that flow from one state to another (Maluwa, 1992:22). To this end it is noted that some 40% of the world's population depends on water from the 214 major river systems that are shared by more than two states. Renner *et al.*, (undated:125) suggest that a reduction in international competition for scarce resources can lead to a reduction in the conflict potential, and the creation of stable ecosystems can bring the reward of increased national security based on international co-operation. The political implications of this are that environmental issues can be solved through co-operative approaches, which can lead to 'interaction' between states and possibly 'spill-over' into related areas, to help overcome other deeper divisions.

Water shortages are posing a severe problem for a number of states, some of which have already triggered disputes and conflicts to which there is no ready solution short of "massive water-management programs" on an international scale (Myers, undated:55). Southern Africa is not entirely free of water related disputes either. The Kasikili-Sedudu dispute is an example of this. This involves a small island in the Zambezi Basin, physically located on the Chobe River, on the border between Namibia and Botswana. This is analysed in detail in Chapter 4. Natural resources are part of the "physical base" of the state (Buzan, 1991:90) and are thus the easiest to discuss as an object of security, because threats to this "physical base" are common in all types of state (Buzan, 1991:91). After remaining a 'sleeper issue' for so long, water can emerge as a major area of renewed international co-operation, if only for national security reasons. Environmental alliances can unite nations that share ecosystems, even if they have a history of hostility, based on the new shared interest in avoiding environmental catastrophes (Renner *et al.*, undated:122). To this end, Africa is uniquely endowed. Of the world's shared drainage basins, 57 are in Africa. This represents a disproportionate share in relation to surface area. Of these, the Nile and Zaire (Congo) Rivers run through nine states, while the Zambezi River runs through eight (Myers, undated:51), offering a unique opportunity for regional co-operation. Figure 2 shows the spatial distribution of international river basins in Southern Africa. Water thus becomes the common challenge, uniting all against a shared threat, particularly in Africa.

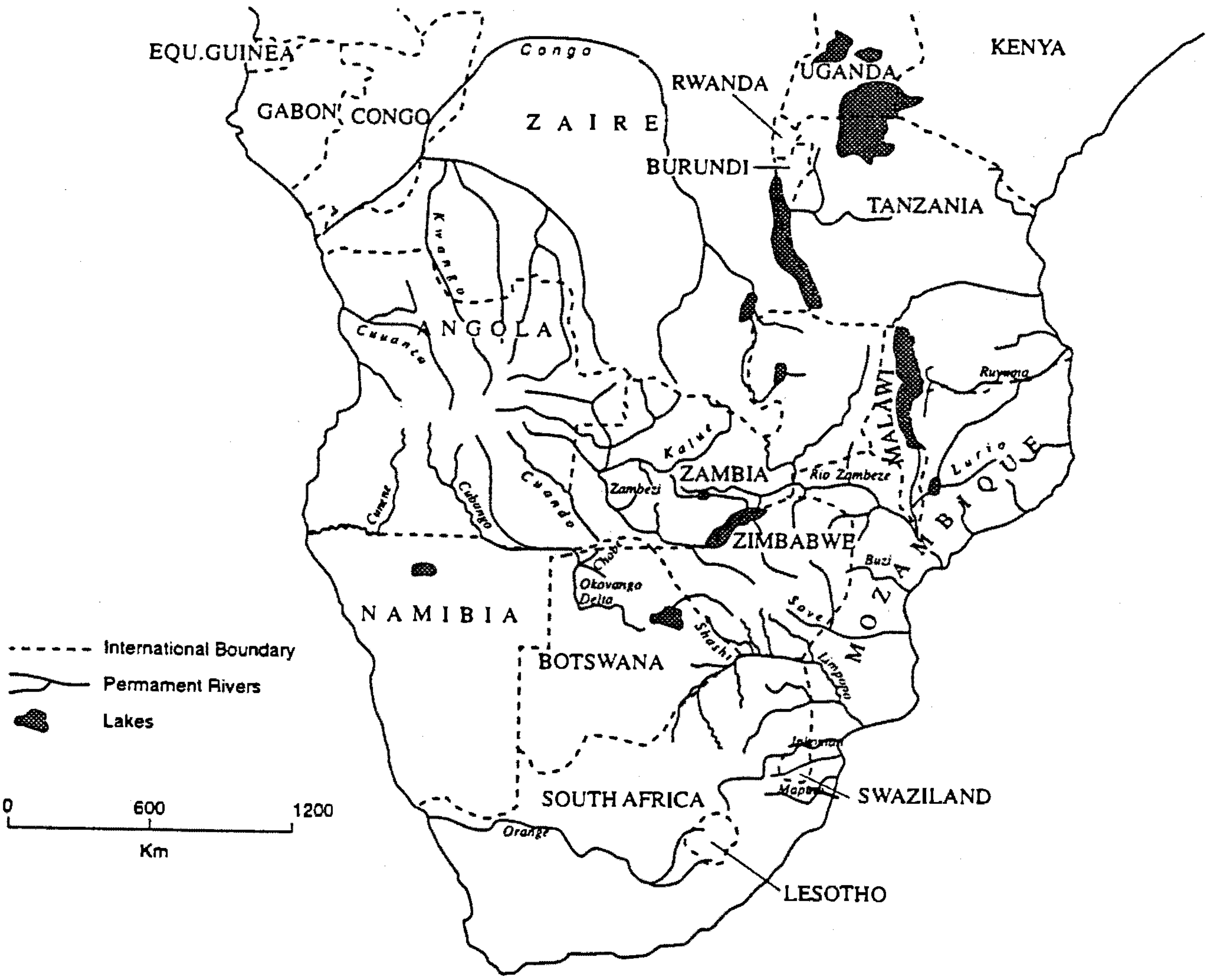


Figure 2. International River Basins in Southern Africa (Arnestrand *et al.*, 1993:9).

The Southern African region contains 15 drainage basins of consequence, 9 of which can be considered as being shared (Ohlsson, 1995a:40). These are presented in Table 1 on the following page. From Table 1 it is evident that the largest river is the Zaire (Congo), which has approximately five times the volume of the Zambezi River. The Zaire (Congo) River has been excluded from this study for reasons noted in terms of the delimitations on page 4. In the long-term, the Zaire (Congo) River is important to Southern Africa however. Firstly, as a source of hydroelectric power, and secondly as a source of water, which can be channelled via the proposed Lualaba-Zambezi IBT down to South Africa and Botswana. The Zambezi River has the largest volume of recoverable water after the Zaire (Congo) River. This situation, coupled with the fact that it has the largest number of riparian states, all of who are members of SADC, makes it the focal point for this study. This is reinforced when the strategic significance of ultimately using the Zambezi River as a conduit of Zaire (Congo) River water down to South Africa is considered. The integration of the water resources of both the Zaire (Congo) River and the Zambezi River into a regionally managed system has come one step closer with the acceptance into SADC of the Democratic Republic of Congo (formerly Zaire) on 8/9/97 (Madakufamba, 1997). The Zambezi Basin therefore enjoys primary research interest at this stage, as the development of this basin is an essential pre-condition for the ultimate possible utilisation of the resources of the Zaire (Congo) Basin by the industrialised south. Table 1 will be referred to extensively during Chapter 3 when the dependence of any one state on a given river system will be analysed.

TABLE 1

MAJOR RIVER BASINS AND FLOWS IN SOUTHERN AFRICA

RIVER	FLOW (KM^3 / YEAR) (*)	SOUTHERN AFRICAN RIPARIAN STATES
Zaire	1,174	Angola, Zaire, Zambia, Tanzania
Zambezi	212	Angola, Botswana, Malawi, Mozambique, Namibia, Tanzania, Zambia, Zimbabwe
Lilongwe	29	Malawi
Cuanza	26	Angola
Rufiji	26	Tanzania
Kilombero	14	Tanzania
Orange	12	Lesotho, Namibia, South Africa
Shire	11	Malawi, Mozambique
Kafue	10	Zambia
Luangwa	8	Mozambique, Zambia
Okavango	8	Angola, Botswana, Namibia
Lurio	7	Mozambique
Cunene	7	Angola, Namibia
Limpopo	5	Botswana, Mozambique, South Africa, Zimbabwe
Save	5	Mozambique, Zimbabwe

(*) Other sources show different flow rates.

While Table 1 lists the respective river basins creating the impression that they are independent, it should be noted that some are sub-basins of larger systems. For example, the Shire, Kafue and Luangwa are sub-basins of the Zambezi, but being significant river systems in their own right, have been listed separately by Ohlsson (1995a:40). It must also be noted that the problem relating to the availability of data that was discussed in the Introduction is manifest in Table 1. Other sources show different flow rates. This data comes from FAO, (1990) and is useful to indicate relative sizes of the river systems and degree of dependence of any one riparian state. Methodologically, this problem is overcome, at least to an extent, by using data for the final analyses from similar sources. The significance of Table 1 lies more in the fact that it tabulates the degree of dependence of any one state on a given river basin.

Recent work on the relationship between the environment and causes of conflict (Homer-Dixon, 1991:76-116) suggests a clear causal link between 'environmental change' and 'acute conflict'. In terms of this hypothesis, there are four probable causally interrelated social effects that result from an interaction between various environmental factors. These are:

- reduced agricultural production
- economic decline
- population displacement
- disruption of regular and legitimised social relations

Such conflict will probably be acute and is likely to arise first in developing countries. The important point to note in this regard is the fact that political ramifications result from the hypothesised 'social effects' of the environmental factors. Homer-Dixon (1991:80) also notes that,

> "the modern realist perspective that is often used to understand security problems is largely inadequate for identifying and explaining the links between environmental change and conflict. ... Realism induces scholars to squeeze environmental issues into a structure of concepts including 'state,' 'sovereignty,' 'territory,' 'national interest' and 'balance of power'".

Subsequent research (Homer-Dixon, 1994:5-40; Homer-Dixon *et al.*, 1996:9) has suggested that the one renewable natural resource that is most likely to stimulate interstate conflict is river water, as it is critical for national survival, while it flows through various states, defying the sovereign aspirations that each may have. Conflict of this nature is most likely to be upstream / downstream driven, particularly if the lower order downstream riparian state is militarily strong and perceives its interests to be threatened by a militarily weaker, higher order upstream riparian rival. This is evident on the Nile River with Egypt being the militarily stronger lower order riparian. On the Orange River, South Africa has also been mentioned as having this propensity (Ohlsson, 1995a:10; Homer-Dixon, 1994:19) regarding access to the headwaters that come from the Senqu River in Lesotho, and which have subsequently been harnessed by the LHWP. Access to viable agricultural land is also identified as a potential source of conflict. The three types of conflict that are likely to be environmentally related are:

- Simple-scarcity conflicts, primarily over competition for water and arable land. Examples of this are wars fought over access to scarce but strategically significant resources. During World War II Japan sought to secure oil, minerals and other resources from China, and the 1991 Gulf War was at least in part motivated by the desire for oil (Homer-Dixon, 1994:18).

- Group-identity conflict (ethnic clashes) due to migration pressures bringing groups into competition. Examples of this are the mass migration from Bangladesh to India causing group-identity conflicts in the adjacent Indian states (Homer-Dixon, 1994:21).

- Relative-deprivation conflicts which often affect economic productivity in poor countries. Examples of this are the erosion of land in upland Indonesia, erosion along the Magat watershed on the northern Filipino island of Luzon and the dryland degradation in Burkina Faso, all of which reduces the states' GDP (Homer-Dixon, 1994:24).

The role of 'environmental scarcity' in these conflicts is often obscure however. The scarcity generates social effects such as poverty and migration, which analysts often incorrectly interpret as the conflict's immediate causes (Homer-Dixon *et al.*, 1996:6).

This is also the appropriate time to note a dilemma that the research presents. Many of the authors consulted were opposed to the Realist perspective. This is clearly evidenced in Homer-Dixon's (1991:80) quote used on page 22 for example. The alternative approach used by some is that of Idealism. While this is good and well at the level of theory, in practice states, as hydropolitical actors, seem to behave in terms of the Realist paradigm. Logically, Functionalism or Neo-Functionalism as an approach, seems better suited for the solution of water related problems, as they focus on technical co-operation. Unfortunately, the evidence uncovered during this research suggested that states behaved more in keeping with a Realist perspective. This factor is evidenced throughout this study, and will be discussed in greater detail as it emerges.

Frey (1993:59) notes that the problem with the above type of approach is that it is too general, and does not bring out the key features of water resource conflict as distinct from other types of conflict. It is noted that water has four primary characteristics of political significance:

- extreme importance
- scarcity
- maldistribution
- being shared

Frey then develops a model with a basic capacity to predict the potential for severe conflict among riparians (Frey 1993:66). This is based on three elements:

- the importance of the water to the state
- the relative military power of the state
- the riparian position of the state

Lowi (1990) uses a model that is similar to guide her research. This model was developed by isolating those variables that were of primary concern to the riparian states in the Euphrates, Indus, Nile and Jordan Basins. Lowi notes (1990:4) that the study of these four cases revealed the following:

- All four cases are located in arid or semi-arid regions.

- In all cases the water is used for productive activities - industry, agriculture and domestic consumption.

- For some, or all of the riparian states in each case, unimpeded access to the water resources is linked to national security concerns.

- In all but the Nile case, protracted political rivalry characterise the relations among some, if not all, of the states.

- In all four cases, efforts have been made to reach a co-operative, basin-wide arrangement for the utilisation of the waters of the basin.

- In none of the cases has the final result been the optimal pattern of river basin development via unitary, basin-wide planning and management.

This last point is important to note in the context of the current research. If this is the case in Southern Africa, then the potential for a 'virtual water' based co-operative solution to the problem may not be achievable. The reason is that for the benefits of 'virtual water' to be manifest, a high degree of co-operation between states is necessary. This co-operation needs more than just a Protocol to be achieved.

In the current research of the Southern African case, a large number of similarities are noted with Lowi's work and are considered to be of importance. These are:

- Large portions of Southern Africa are arid or semi-arid.

- In certain of the more developed states in the Southern African case, there is a high reliance on surface water for productive activities such as agriculture, industry and domestic consumption. In the case of South Africa and Botswana, there is simply no more significant surface water left to exploit, so in these cases, economic activity is becoming more dependent on access to water, and hence becoming more of a national security issue.

- While unimpeded access to the Zambezi River is important for certain riparian states, this access is possibly vital for one non-riparian - South Africa. In this case all available surface water in South Africa will have been exploited by the turn of the century, and it is argued that future national survival will increasingly be linked to the development of alternative water strategies. One potential strategy involves uninterrupted access to the only available water in the region, that of the Zambezi River. Being a non-riparian state, this means that South Africa will be forced to negotiate access, which will make South Africa increasingly vulnerable to the political interference of other states.

There are also a number of differences between the Southern African case and those studied by Lowi. These are:

- There is no history of protracted rivalry between the Zambezi Basin states, although there has been a history of rivalry with South Africa over the policy of apartheid. This has now ended with the democratisation of South Africa, and the resultant incorporation of that state into international regional institutions, such as SADC, as a legitimate member. This rivalry is different in nature to that found in the Jordan Basin, as the riparian disputes there were regarded as a manifestation of the larger inter-state conflict (Lowi, 1990:375).

- Regarding the concept of protracted rivalry, the case of the Kasikili-Sedudu dispute needs to be clarified at this early stage. This does not fall into the category "protracted rivalry" by definition. This conflict can best be labelled as a "riparian dispute". This is also the only known case where a military angle was involved. It can thus be said that there is no evidence of a protracted rivalry in the Southern African study area at the time of doing the research.

- There are indications of an attempt to create a legal regime in the form of the Protocol on Shared Watercourse Systems in the Southern African Development Community (SADC) Region. Should this succeed in the establishment of a basin-wide arrangement it will be at odds with Lowi's findings unless this is beneficial to South Africa and/or Zimbabwe.

It is therefore felt that Lowi's research is more relevant than the others mentioned. To this end, Lowi's isolation of the key variables that were particularly evident in her study of the Jordan Basin is considered to be appropriate (Lowi, 1990:11-13). Lowi (1990:13) notes that these variables were also evident in the studies of the Euphrates, Indus and Nile Basins, so an element of universality is present, suggesting that they may be appropriate to the analysis of the political dynamics in the Southern African case study. These are:

- **Resource need / dependence**. How vital to a state's socio-economic development is access to the water supply of the basin? How dependent is the state on that water supply? Does / could it have access to other sources, outside the basin? Relative to other states in the basin, can the state be considered 'resource poor'? Is the state's survival dependent upon continued access to the basin's water supply?

- ***'Rapport de forces'* / relative power position in the basin**. The French term for 'balance of power' is used because semantically it connotes a conceptually distinct notion. Implicit is that the "structure" of states in any system is not static; it is a process that is both dynamic and interactive over time. States, as political actors, interact in relationships. As with all relationships, those among states are subject to change. Moreover, relations among states are relations of power. Specifically, the term refers to the relations of power and relations of forces - the composite of power resources available to one actor relative to that of the other actor(s) with which it interacts. Needless to say, its status, or perceptions of its status, within the 'rapport de forces' configuration, in part condition a state's international behaviour.

- **Character of riparian relations**. The fact of an over-arching political rivalry, (subsumed are three variables):

  ⇒ protracted nature of conflict

  ⇒ concern for identity, recognition, legitimacy and survival

  ⇒ perceptions of the adversary

  What is it about the political conflict that influences the way in which a state responds to a dispute over water resources? Is it the protractedness of conflict, or rather, the fact that it engages visceral concerns, organising principles, and 'core values'? How do these factors influence responses? No doubt, perceptions inform the behaviour of states as well; in fact, it is on the basis of their perceptions of the environment that states formulate policy and take action.

- **Efforts at conflict resolution** and third party involvement. Have there been attempts to resolve the conflict? Is the mediator's role perceived by all parties to the conflict as a positive one? Is the mediator perceived as being impartial? Does the proposed solution to the riparian dispute reflect the context of relations in the basin?

The first three aspects are used to refine the HPRP of the Zambezi Basin states and South Africa that emerge from the WBS and WSI analysis in Chapter 3. In this way, the necessary synthesis is achieved between the disciplines of hydrology and political science, which makes the methodology of hydropolitics unique. The fourth aspect is not considered relevant, as there is no case history of protracted conflict being studied in the Zambezi Basin. This variable will only be used where there is evidence to support it such as during the Kasikili-Sedudu Island dispute.

Lowi (1990:12) notes that of these variables, only *resource need* is specific to riparian issues. The rest are linked to a variety of theoretical literature relating to International Politics. *Rapport de forces* is linked to hegemonic stability theory and realism. *Riparian relations* has roots within neo-functionalist theory. *Conflict resolution* rests on the literature linked with the politics of mediation.

The literature related to the politics of resource scarcity tends to be divided into two broad schools; one pessimistic (Realist) and the other optimistic (Idealist). In terms of the Realist view, the feeling is that common problems will not necessarily lead to global co-operation. National interests prevail in a pattern of state-centric behaviour, often apparent when shared resources are to be allocated, when priorities have to be established among conflicting uses, and when decisions have to be enforced (De Jager, 1996:8). For example, Jordan and Syria's attempts to divert the Jordan River were one of the reasons why Israel went to war in 1967. During this conflict, Syria's Baniyas River was captured - the last of the important Jordan headwaters not yet under Israeli control - and construction of a dam on the Yarmuk River was halted (Hudson, 1996:7-8). This clearly indicates that in the Middle East, water can be regarded as 'high politics'. The Realist critics of Functionalists seem to be correct in the case of arid regions, such as the Jordan and Indus Drainage Basins, in the sense that states which are in conflict over 'high politics', seem not to allow co-operation in areas of 'low politics'. 'Spill-over' is thus prevented under such circumstances (Lowi, 1990:375).

The Idealist school encompasses that which is known as Functionalism and Neo-Functionalism. These two schools, along with International Regime Theory, suggest why and how states may co-operate in areas of mutual concern such as in areas related to shared water resources. In addition, both Functionalists and Neo-Functionalists try to show that functional co-operation could be an avenue to both peace and/or regional political integration (Lowi, 1990:15).

Lowi (1990:18) notes that Functionalists see their principle task as the reduction of the intrusion of 'power politics' and a reconciliation of the contradiction between nationalism and the growing need for unity in an increasingly interdependent world. Mitrany believed that sacrifices in national sovereignty were needed in the interests of peace, and that this could best occur via functional co-operation across national borders, with the ultimate creation of supra-national task-oriented organisations through which economic unification would strengthen the foundation of subsequent broader political agreements. 'Spill-over', as an essential dynamic within the process, would proceed from this and ultimately result in functional integration. This functional co-operation is in fact similar to certain of the solutions being advocated as optimal strategies for the development of the waters of international drainage basins. In fact, Mitrany believed that his formula was *the* ideal solution for international river (drainage) basins (Lowi, 1990:30). In the Foreword to the 1966 re-edition of *A Working Peace System*, Mitrany maintained that in the Indus and the Jordan Basins for example, fair and workable schemes had been devised by impartial agencies, but both were blocked by what he described as "political spite".

Neo-Functionalists such as Haas later modified Functionalist theory, especially where it applied to task-based co-operation and the potential for 'spill-over' (Lowi, 1990:19). Subsequent experiences from the EU have shown that politics and ideology cannot be circumvented when it concerns integration (Lowi, 1990:20). Haas has since acknowledged that 'spill-over' is not automatic, and that it would only occur if actors desire to adopt integrative lessons learned in one context to a new situation. Nye took this further than both Mitrany and Haas, by pinpointing several mechanisms that condition the potential for integration, which can be significant in the context of international drainage basins. Among these are the active involvement of third parties (International Aid Agencies, NGOs etc.,) which can serve as catalysts in co-operative schemes. Nye notes that the degree to which elites in the potentially integrating states think alike (elite value complementarity), is of major significance to the outcome of integrative efforts (Lowi, 1990:21). Perceptions concerning the equitable distribution of benefits, which could be derived from co-operation, could trigger off 'spill-over' into other issue-areas.

The discussion of Functionalism versus Neo-functionalism is a complex one indeed and belongs more to a purely political science approach. This in fact goes beyond the intended scope of this study, which has a specific hydropolitical bias instead. It is therefore considered to be prudent to leave the matter with the discussion of how Lowi (1990) views it, as greater analysis of this specific issue will not add value to the final product and could actually side-track the intended methodological thrust.

Lowi's Theory of Hegemonic Co-operation

While Functionalism seems to provide an alternative to Realist theory that is seductively logical and therefore compelling, Lowi (1990:19) notes that it is hard to escape the conclusion that its relevance is limited to those unique circumstances in which there already exists a high level of shared values arising from overlapping role behaviour. This is further evidence of the dilemma noted on page 23.

Lowi (1990:22) concludes after her study of the Jordan River Basin, that the hydropolitical dynamics prevalent there, build upon an interaction between Neo-Functionalism and Hegemonic Stability Theory - what she calls a 'Theory of Hegemonic Co-operation' (1990:23). Aspects of this are considered to be relevant to the current research. This theory is as follows:

In arid regions, water scarcity is a physical constraint to the survival of the state (Lowi, 1990:364). Under such circumstances water resources and hydraulic installations have often been treated as prime targets in conflict situations. The magnitude of the link between water and state survival is most pronounced in the case of Egypt, where the Nile is the only source of water available to a population in excess of fifty million people. Egypt is a low order riparian being located the furthest downstream. This is the least favourable position to be in, as an upstream rival can theoretically divert the water. This is unlikely because the *rapport de forces* position favours Egypt however, whose superior military power acts as a deterrent (Lowi, 1990:365). Israel also regards water as a vital national security issue (Lowi, 1990:366). The groundwater reserves of the West Bank provide one third of the total water supply in Israel, thus loss of control over the West Bank is perceived by some in Israel to be a profound threat to both security and national survival (Lowi, 1990:367).

This raises the issue of relative gains, which is central to the 'theory of hegemonic co-operation'. In the case of protracted conflict, neither side is willing to engage in any activity that is likely to strengthen the "enemy". Thus if one side agreed to share water resources, they would be contributing to the improvement of the situation of the adversary (Lowi, 1990:368). The concern for relative gains, and with it the overall significance of the larger political rivalry, recedes in importance only when one party or the other, but especially the most needy, is sure to experience substantial material gains, by sharing the water resources in a co-operative arrangement (Lowi, 1990:370). This implies that the Functionalist type of argument is not necessarily feasible under such conditions. Up until 1990, functional type of arrangements in the Jordan Basin have been possible only between two of the four riparians, and where achieved, they have been exceedingly fragile and limited to one specific task only (Lowi, 1990:371). Of the four Jordan Basin riparians, both Israel and Jordan are of a lower order, while having the greatest need for the water. Lebanon and Syria have a higher order riparian position and also have a lower reliance on the Jordan River, but they regarded the river system primarily as a geopolitically strategic resource vis-à-vis Israel (Lowi, 1990:372).

In the case of the Jordan Basin, regimes for the regional development of water resources could thus not be realised, due to the 'cognitive' variables evident in the broader context of interstate conflict, contrary to Neo-Functionalist theory (Lowi, 1990:374). This is further supported by the case of the Indus Basin, where the river system was partitioned into two - one for India and one for Pakistan. There was thus neither interdependence nor interaction. The Realist critics of Functionalists thus appear to be correct. Under conditions of conflict relating to the 'high politics' of war and diplomacy, states seem reluctant to collaborate extensively in areas of welfare and economic 'low politics'. It thus seems impossible to de-link issues under the circumstances of the coexistence of a riparian dispute and a protracted political rivalry. Under such circumstances, the riparian conflict becomes intimately linked to the larger political rivalry. The smaller riparian dispute is regarded as a manifestation of the inter-state conflict. Functionalists and Neo-Functionalists fail to factor into their analyses, the fact that interests emerge within the context of a specific normative system and historic experience. National interests and foreign policy behaviour are responses to environmental constraints that are normative in nature (Lowi, 1990:375).

When technical co-operation has been achieved in the international river basins that have been studied, riparians have de-linked specific issues, and the arrangements concluded have been highly specific (Lowi, 1990:377). In the case of a riparian dispute, the factor that will probably lead states to seek technical arrangements is that of acute need for water resources and/or dependence on a specific shared body of water. Under these conditions, the failure to establish a water-sharing regime would be considered threatening to the continued survival of the state. This interest in establishing a regime is heightened where the resource need is coupled to a relatively inferior power position (Lowi, 1990:378). It is argued that this is the case of South Africa, that has a high resource need, and given the fact that it is not a Zambezi Basin riparian, is in an inferior power position.

The converse also holds true in terms of Lowi's theory. If a riparian state has a low resource need, and/or has a superior power position relative to others states (either in terms of military capacity, high order riparian status, or both) it will have little incentive to establish a regime (Lowi, 1990:379). Hence there is no evidence of co-operative arrangements where threats to state security in the form of resource need do not inhere, and where they are not imposed by a hegemon. When technical arrangements are established among adversarial riparians in arid regions, they have no implications for the ending of the political rivalry. Contrary to the predictions of Functionalists, no efforts are made to 'enmesh' the rival in an ongoing process of interaction (Lowi, 1990:380). There is consequently no conflict resolution potential in such arrangements (Lowi, 1990:381). Where potential threats to national security exist in the form of denial of access to water resources, the concerned state is likely to regard the source of water as having acute conflict potential. Where states do not regard the water resources as vital, or where the state concerned is hegemonic in terms of a superior *rapport de forces* situation (and hence has the means to satisfy its perceived needs by the resort to force), the same water resources will not be regarded as a source of conflict (Lowi, 1990:382). For example, Israel does not regard water as an acute source of conflict with Jordan, except in one particular case. In terms of Lowi's theory, threats to the survival of a state profoundly affect perceptions, even those of a hegemon that fears it may not be in a position to harness available power resources to avert the menace (Lowi, 1990:183-4).

Evidence of the reluctance of riparians to co-operate with adversaries in arid areas in seemingly technical matters is an indication of the Realist view that these reflect the 'high politics' conflict (Lowi, 1990:384). In none of the riparian disputes studied by Lowi has the outcome been determined by the political conflict. In the case of the Jordan Basin, the states most dependent on the river seem to allow the overall political rivalry to recede into unimportance, when the gains from a regime creation are substantial. To ensure survival, both Israel and Jordan have been prepared to set aside the Arab-Israeli conflict on several occasions. While the fact of resource need and dependence will prompt states to seek co-operative water utilisation arrangements, the *rapport de force* situation within the basin influences both the desire for, and the creation of, a regime. In the case of the Euphrates, Turkey is both the hegemon and high order riparian, and can thus prevent a regime between Syria and Iraq, as it would be to the disadvantage of Turkey (Lowi, 1990:385).

Lowi (1990:386) thus concludes, that in all of the river basins studied, a variant of the theory of hegemonic stability holds true. In all cases the final outcome reflects the *rapport de forces* situation. Co-operation is thus not achieved unless the dominant power in the basin accepts it, or has been induced to do so by an external power. The hegemon will take the lead in establishing the regime, and accepting a regime change, will enforce compliance to this regime, only if the hegemon serves to gain as a direct result. In the absence of external coercion, this occurs in river basins only if:

- The hegemon's relationship to the resource need is critical and is linked to its national security concerns.
- It is not a high order riparian.

Lowi's (1990:386-7) theory of hegemonic co-operation can thus be summarised as follows:

- Co-operation in an international river basin located in an arid region is only brought about by the hegemonic power.

- When a riparian dispute in an arid region unfolds within the context of a more comprehensive inter-state rivalry, the former cannot be isolated from the latter.

- Limited agreements on the sharing of water resources cannot be attained, because the most needy, or most powerful, will derive little benefit from co-operation, as it will mean it has to relinquish its favourable power position.

- The neediest and militarily inferior riparian will seek a co-operative arrangement, despite the larger inter-state conflict, because it has no viable alternatives.

- When there is a regime creation, it is only when the dominant power either wants it, or has been induced to co-operate. The arrangement is highly specific and cannot be regarded as the start of a series of 'enmeshments' that can become an avenue towards a political settlement.

Thus, what Lowi's theory does, is to provide a basic framework for analysis. This is done by adding the necessary political elements to the hydrologically derived data provided by Falkenmark. In short, it can be said that the combination of Lowi's work with that of Falkenmark, enables the hydropolitical problem to be effectively formulated in the first place. This is what makes hydropolitical methodology possible.

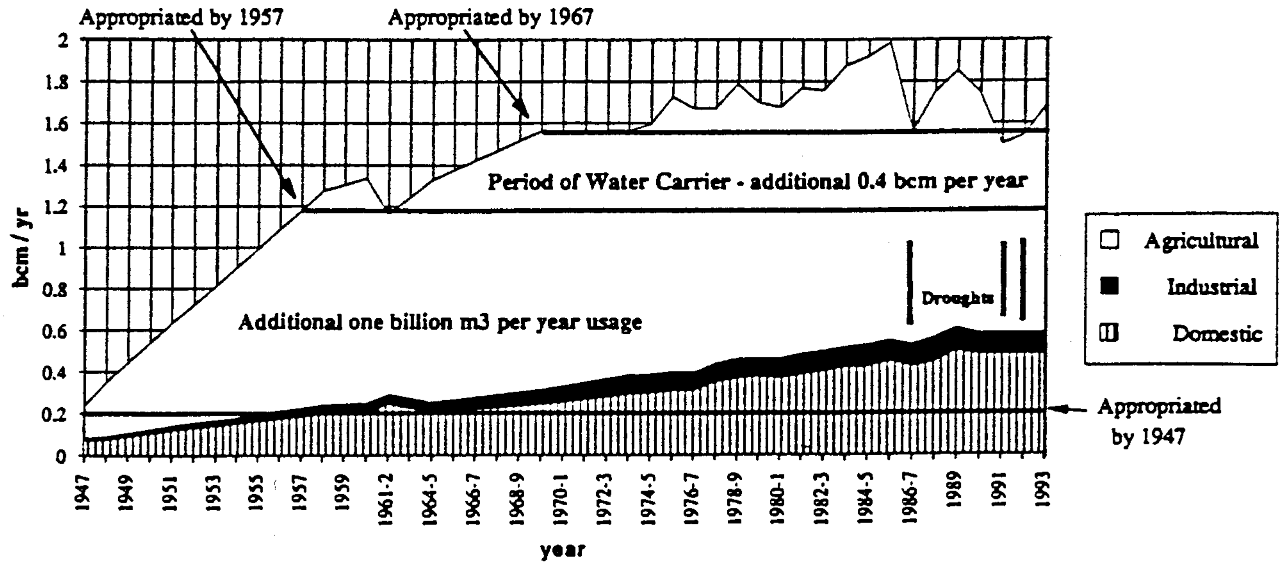
Allan's Concept of 'Virtual Water'

'Virtual water', as a new concept, plays a significant role in this research. The White Paper on Water Policy calls for research in this regard (DWAF, 1997:6.6.2). If the combination of the concepts used by Lowi and Falkenmark, define the hydropolitical problem by isolating key elements of the equation, then Allan provides a potential solution. Given the fact that the reader is probably unfamiliar with Allan's concept, coupled with the fact that terminology such as 'virtual reality', which is bandied about as the result of the computer age, can lead to some confusion. What then is 'virtual water'? Reference to the definition in the Introduction indicates that it represents the volume of water that is present in any commodity, product or service. Allan (1996b) developed the concept, after an economist by the name of Fishelson, proved via conventional economic analysis that the export of water from Israel, in the form of citrus and other agricultural produce, was no longer in the national interest of Israel. This effectively amounted to the exportation of water, from a water-scarce economy, to an economy (Europe) that was relatively water-abundant. This led Allan to suggest that the policy-makers within water-scarce economies needed to become aware of the relationship between environmental resources and 'development'.

In this regard, an analysis of the global economy of water indicates that vast quantities of water are present in the international cereal market. Typically it takes 1 000 tonnes of water to produce one tonne of grain. In economies such as those found in Canada, the USA and parts of Central Europe, where a naturally high MAP exists, there is an abundance of viable, mainly rainfed agricultural production. The governments of these grain-producing states often subsidise the farmers, which implies that the 'virtual water' content of that grain is both high in volume, and cheap in price. Thus, by purchasing water intensive agricultural produce from states that produce a natural surplus, and by re-directing the water-short economy away from a policy of "food security", towards a new policy of "economic security", the water budget can be balanced (Allan, 1996b). Metaphysically, the importation of products that need vast amounts of water to produce, into arid states, represent the actual importation of water into the water-scarce country. Instead of importing the 1 000 tonnes of water needed to produce the grain, it is easier to simply import the one tonne of grain. The availability of 'virtual water' is thus of major significance in the domestic water policies of water-short economies (Allan, 1996e).

Evidence for this can be found in the Middle East. Until 1986, all of the economies of the Middle East were driven by the belief that new water had to be mobilised to meet the rising demands for agricultural, industrial and domestic consumption (Allan, 1996f:107). This is classic 'supply side management' at work, and is similar to that found in Zimbabwe at present and South Africa under apartheid rule. This can change with time however. As economies develop, they gain in diversity and strength, which in turn makes it possible to pursue new and more efficient water allocating strategies, including the adoption of 'demand side management' policies and practices. The availability of 'virtual water' on advantageous terms on the world market for staple grains, has consistently enabled political leaderships in arid regions to provide water for their economies. 'Virtual water' is a particularly important concept, as it is this water which is as significant to the economies of arid regions, as their own naturally occurring scarce supplies.

As an example, as much water enters the Middle East region as 'virtual water' in the form of subsidised grain purchases as flows down the Nile annually (Allan, 1996f:108). Hydrological systems are therefore subordinate to the international political economies of which they are a part. Only the global food trade has the capacity to augment water supplies on the scale needed to meet the growing demands of the rising population of the Middle East region (Allan, 1996f:109). This can be illustrated by referring to the case of Israel from 1947 to 1993, which is presented graphically in Figure 3.



Source: Abstract of Statistics of Israel.

Figure 3. Israeli water consumption by sector from 1947-1993 (Allan, 1996c:85)

Allan (1996f:111) notes that the Israeli case indicates that a major element in the solution to the water problems lies in economic development ('demand side management') and not merely in gaining access to more water ('supply side management'). This is evidenced in Figure 3 by the additional amount of water provided under the 'supply side management' period of the Israeli Water Carrier from 1957 onwards. This provided additional supply and therefore bought time for the necessary political adaptations to be made.

The opportunity for these adaptations first came in the form of the drought of 1986, which triggered a debate within the water consuming and policy communities in Israel (Allan, 1996f:111). Until this date, it had been impossible to get the subject onto the political agenda, because the interests of the farming community were so strongly represented in the national political system. The 1986 drought is thus seen as being an essential event in making the discourse possible. The following drought of 1991 made it possible to introduce additional "environmentally rational" policies. These resulted in a policy aimed at a 60% reduction in water allocation to agriculture in 1991. Policies were then put in place to further reduce the allocation of first-use water to irrigation, and to progressively increase the proportion of re-used urban waste water, so that by 1994 over 20% of the water delivered to farmers was coming from treated urban effluent. The result of this is seen as a flattening out of the consumption curve, which is evident in Figure 4, indicating that overall water consumption actually decreased over time.

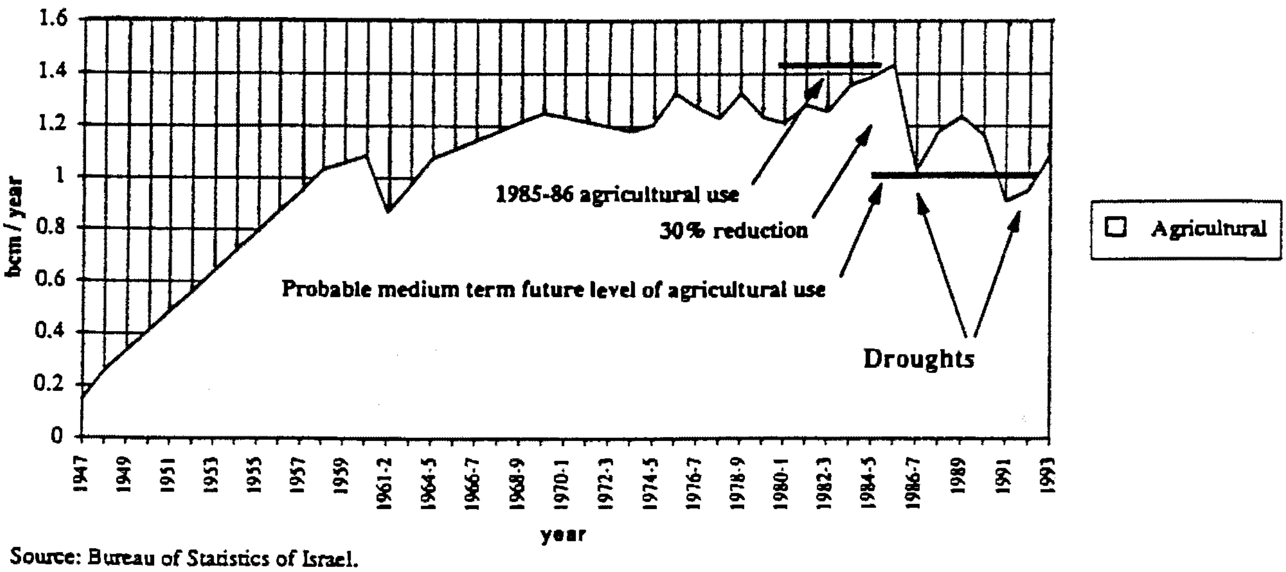


Figure 4. Israeli water consumption showing the effect of drought induced policy adjustment on total sectoral water consumption (Allan, 1996c:87).

The significant point to note, is that Israel could make these ecologically and environmentally rational, but politically stressful 'demand side management' decisions, because it had developed a political economy by 1986, with the economic diversity and strength to enable it to consider alternative water strategies. This in turn enabled a fundamental re-evaluation of the role of water in the economy to take place (Allan, 1996f:112). Allan (1196f:114) therefore concludes that, despite needing up to four times more water than is available, the individual political economies of the Middle East have not resorted to the hot conflict that has been so confidently predicted, because of access to 'virtual water' on favourable terms.

The successful transition that Israel made from 'supply side management' to 'demand side management', has not been evident in the case of Jordan. This is shown by the constantly climbing total consumption curve with no evidence of a flattening out other than during periods of drought (1986 and 1991). This is illustrated in Figure 5.

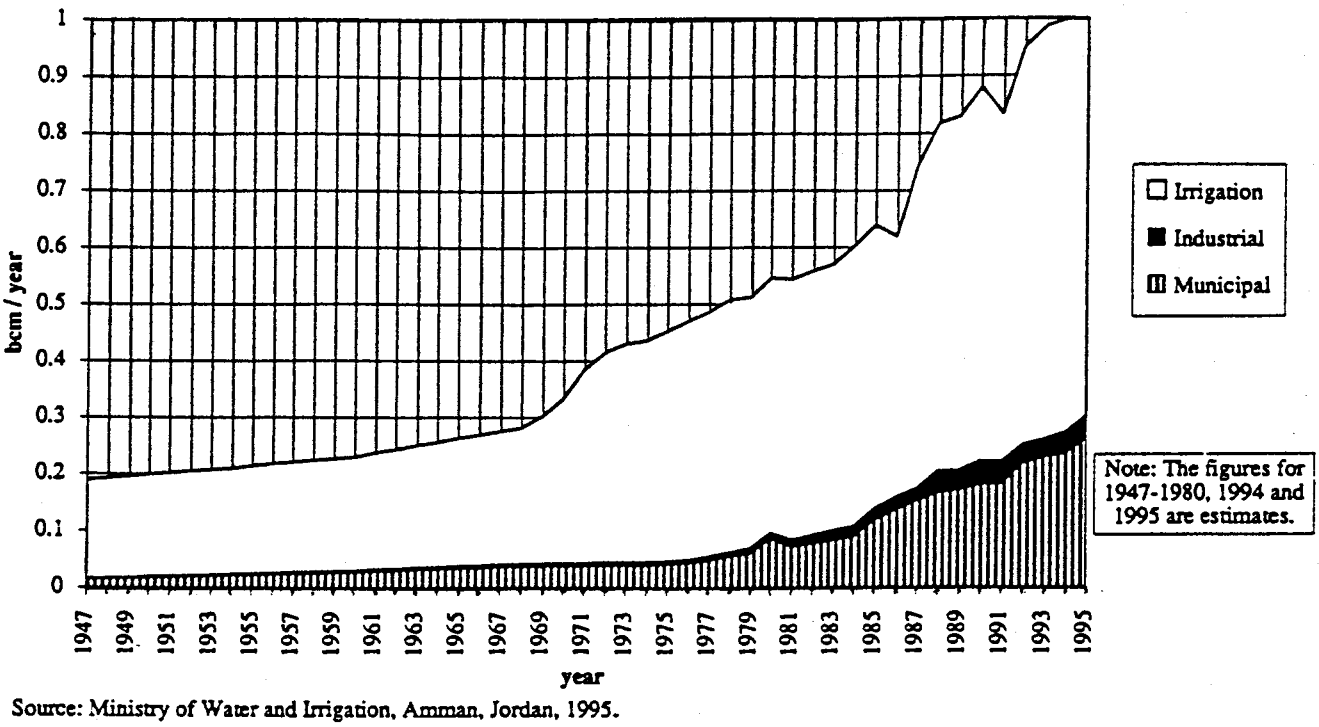


Figure 5. Jordan's water consumption by sector 1947-1995 (Allan, 1996c:86).

Allan (1996c:79) provides a useful graphic model, that indicates the effect of the transition from 'supply side management' to 'demand side management', on total water consumption in the Middle East. This is presented as Figure 6. Attention is drawn to the regional water deficit that was supplied by 'virtual water' in the form of staple food imports. Had this not taken place by means of economic transformation, then the demographically induced total demand would not have been effectively met. This is a classic representation of the potential that 'virtual water', as a component of 'demand side management' has, of providing a viable alternative supply, other than via a series of major IBTs.

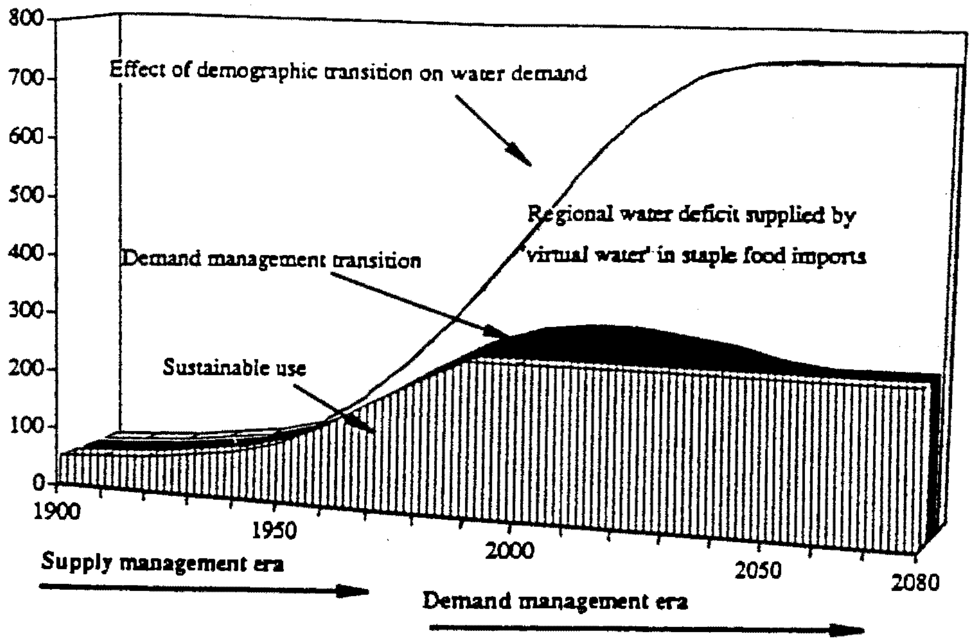


Figure 6. Phases in water management in the Middle East showing the impact of 'virtual water' importation (Allan, 1996c:78).

A better understanding of Allan's concept of 'virtual water' can be achieved by focussing more on the theoretical components inherent to the concept. History provides an excellent example of the results of a policy, designed to meet a major water shortage, by attempting to transport water in bulk, directly to the point of consumption. This classic example of 'supply side management' is provided by the so-called "Great Man-Made River" in Libya (Allan 1994:75). This project was a bold attempt to address water deficits along the coastal tracts, by abstracting and moving groundwater, from the ancient aquifers located in the desert, to where it was needed. This was deemed to be necessary, because of the adverse climatic conditions that negatively impacted on economic development, close to where the water was located. A huge pipeline was designed to deliver between 2-3 km^3 / year - almost double the present national consumption.

The political roots of this project can be traced back to the revolutionary seizure of power in 1969. The costs of resource mismanagement during the early years of the revolution were relatively insignificant, when seen against the background of the rapid increase in oil derived revenue, which characterised the period 1973-79. During this period Libya seemed to be prosperous, so the contemplated benefits of high-cost supply side solutions, seemed attractive to the leadership at the time. The first phase of the Great Man-Made River Project was commenced at a cost of around 15% of the oil revenue earned in 1980 (US$ 23 billion). At this early stage it was estimated that further phases would cost at least four times this amount. The sum of 12% of GDP to be spent over a decade was considered a reasonable price for securing strategic water supplies.

During the 1980s Libya fell on hard economic times. Revenues fell to one quarter of their 1980 levels, and the strategic investment in water security began to dominate the national economy, even though the construction schedule was to continue for at least two more decades. The most disturbing aspect of this case study, is the apparent unwillingness of the political leadership to shift its perception of the benefit - cost ratio of the project, within the context of the changed economic circumstances of the 1980s (Allan, 1994:76). A high proportion of the water, delivered at an approximate cost of US$1,00 / m^3, went to irrigated agriculture. This economic folly apparently ignored the relationship of using over US$10 000 of water / hectare (excluding the cost of other economic inputs), to produce crops yielding a paltry value of between US$1 000 and US$2 500 / hectare. What increases the magnitude of this folly is the fact that the water found in the aquifers is ancient in origin, so aquifer recharge is negligible. In other words the resource is non-renewable, and when exhausted will not be recharged. Libya's rich-country approach to water resource development simply no longer relates to the changed economic circumstances that currently prevail. This also teaches us a lot about the relevance of long distance water carriers (IBTs, pipelines and canals), to solving the water scarcity problems of arid regions, when not coupled to demand side management policies and strategies.

Inherent in the above case study, is the belief that re-allocating water from economically water-inefficient applications, such as irrigated agriculture, to meet the needs of domestic consumption, becomes a primary concern for governments in water-scarce regions. Implicit within this process of reallocation of water away from economic sectors with a low SWE, is the fact that neither the delivered cost of water, nor the capacity to pay for it is uniform (Allan, 1994:83). On the supply side, water availability can be categorised in terms of volume, reliability, quality, location, cost of delivery and by reference to the source - rainfall, indigenous surface flows, shared surface flows, groundwater storage, recycled effluent, desalinated water, imported water or *imported water incorporated in other imported products* ('virtual water').

On the demand side, similar criteria are relevant, but to these must be added the cost of various uses, locations and sectors. In practice cheap water is always limited, and new water is always going to be costly in arid states. The problem lies in the politics, with no leadership, or high-volume consumer of water, being prepared to disaggregate the supply or demand of water (Allan, 1994:84). To this end Allan (1994:87) notes that water demand in Arab countries is driven by four main factors. These are:

- Level of population and the rate of increase.
- Standard of living and expectations of the future.
- Allocation of water within the economy, to a given sector (agriculture, industry or domestic), and within each sector, to the allocation of final use such as choice of crop or product produced.
- Efficiency of the systems used to deliver water.

This leads to the need for an understanding of the way that water is allocated in terms of optimum efficiency. Since water is mostly regarded as a free commodity, especially within the sector that is traditionally the heaviest consumer - agriculture, vested interests for continuing the practice of free water provision are powerful (Allan, 1994:88). The concepts of 'returns to water' and 'sectoral water efficiency' (SWE) therefore become significant in arid regions.

Allan draws heavily on the theoretical modelling of Karshenas, an economist from the School of Oriental and African Studies (SOAS) at the University of London. Karshenas has developed a model in which he shows the relationship between environmental capital and economic development. This is useful as it shows how a developing state uses, and sometimes even abuses, natural resources in an attempt to develop. The green movement of the 1980s has raised awareness of this factor to such an extent, that the concept of sustainability is now so well established as a political factor, that economists are beginning to provide an economic rationale for the concept (Allan *et al.*, 1996d:125). The concepts and processes relevant to sustainable resource use, especially the valuation of 'environmental capital' such as water, have proven difficult to define and operationalise. This has resulted in what economists refer to as a 'precautionary principle', which generally recognises the difficulty of establishing the cost of resource degradation. A sound principle is that economic development should not reduce the stock or value of environmental capital such as water for future generations.

The Middle East region has a rich history of sustainable economies from the past, and provides a number of good examples of this precautionary approach. This is illustrated in the Karshenas model that is presented below. Figure 7a is an attempt to conceptualise the relationship between economic development and the use of environmental capital such as water. The portion on the top right-hand corner of the graph is the space where development can take place in a sustainable manner. The area to the left and below this represents the depletion of resources in an unsustainable manner. The zones adjacent to the axes are those of ecological and Malthusian catastrophe, where ecological and possibly even economic circumstances become irreversibly degraded. The illustrated developmental trajectory is similar to that of poor countries in marginal circumstances such as those found in sub-Saharan Africa.

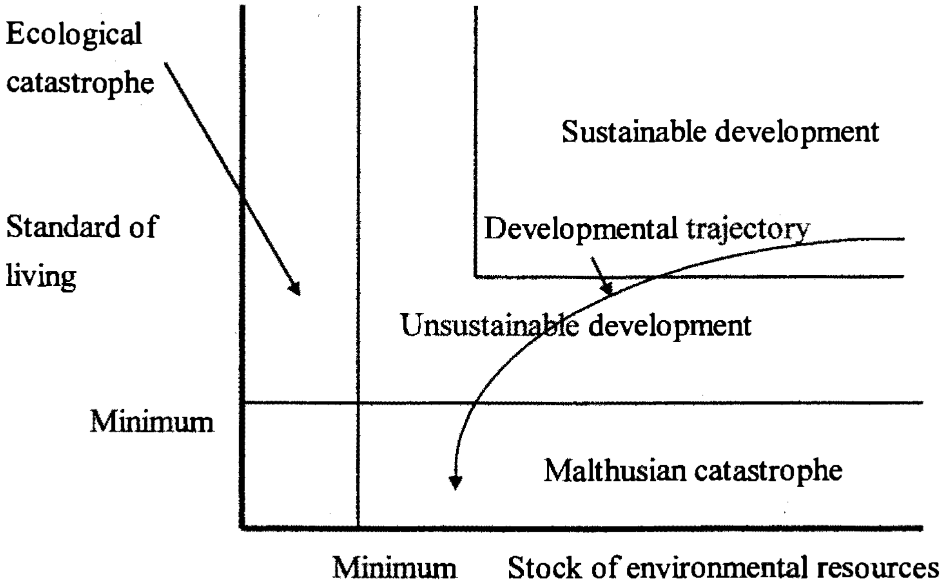


Figure 7a. Concept of 'eco-environmental space' showing the consequences of low environmental capacity and over-use of environmental capital (Allan *et al.*, 1996d:127).

Figure 7b shows the same model, but with two differing developmental trajectories. The lower one is that of a conventional trajectory in the early phases of economic development. During this phase, environmental capital is commonly degraded. The upper case is the trajectory typically advocated by ecologists and environmental economists, where economic development is achieved with no degradation of environmental capital. This model shows that in the early stages of development, a degree of over-exploitation may occur, but that this is not necessarily irreversible, provided that policy interventions are made and implemented in time. It will later be shown that both South Africa and Botswana are making the transition from the 'conventional trajectory' to that of the 'precautionary trajectory' regarding water.

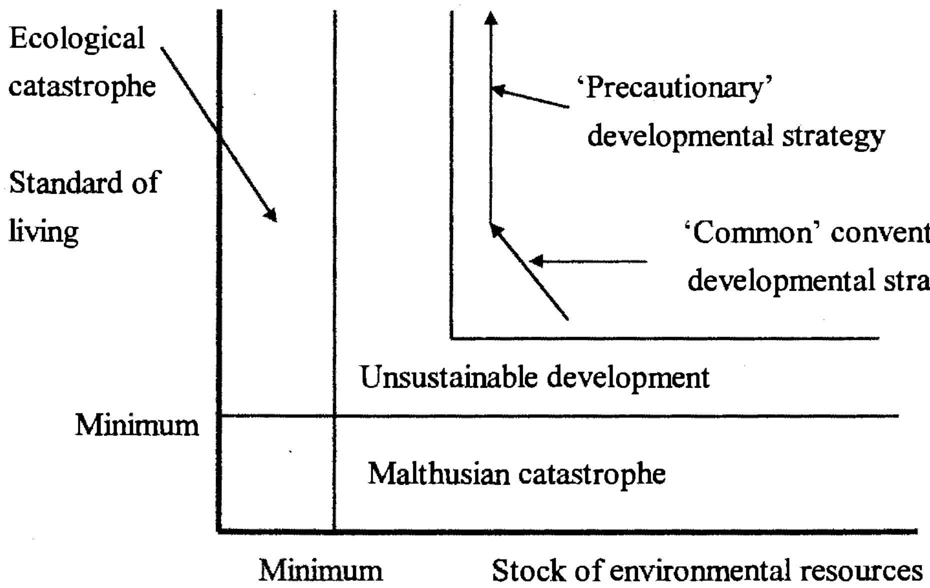


Figure 7b. 'Common' and 'precautionary' developmental trajectories (Allan *et al.*, 1996d:127).

Figure 7c is the trajectory identified by Karshenas, as reflecting a 'normal' pattern for the use of environmental capital, in which there are phases of resource use. Initially, environmental capital is used to develop the economy and improve the welfare of the citizens. This may be beyond the threshold of sustainability in the short-term, resembling a degree of 'over-exploitation'. As the economy develops by the adaptation of new technologies, as well as by the integration of the national economy with larger regional or global economies, a new series of resource options begin to become available. With the increasing strength and diversity of the developing economy, policy-makers can begin to contemplate the introduction of politically costly 'demand side management' options, specifically by re-allocating water from one economic sector to another. This has been described by Karshenas as "natural resource reconstruction" (Allan *et al.*, 1996d:127-8). This is shown in Figure 7c overleaf.

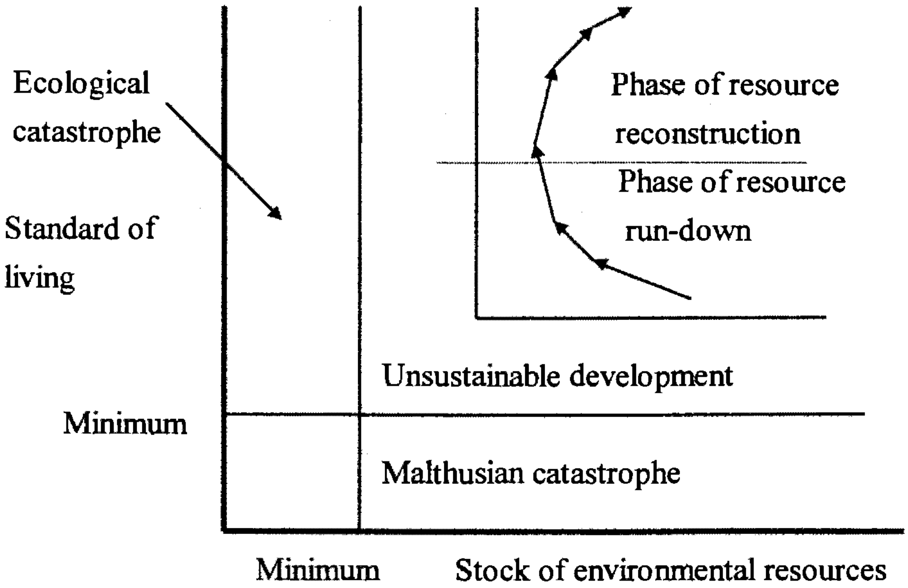


Figure 7c. Diversifying economy trajectory (Allan *et al.*, 1996d:127).

This diversifying economy trajectory has been found to exist within the Middle Eastern economies that have been studied by Allan (1996d:128). The data recently gathered from Israel, the West Bank and Gaza is presented in Figure 7d overleaf. Allan (1996d:128) notes that this evidence "powerfully confirms the relevance of the trajectory" depicted in Figure 7a. The Israeli trajectory conforms to that which would be expected of a diversified industrialised economy. By the second half of the 1980s, it became evident that the water consumption policies were unsustainable, and had to be modified. The reader is referred to Figure 3 on page 35 in this regard. By this stage Israel had made the transition to an industrialised economy, so the implementation of 'demand side management' strategies and policies were possible through a protracted period of dialogue between the principle stake holders - government and agricultural interests.

It should be noted that economies relate to each other. In the example represented in Figure 7d (shown overleaf), the stronger economy of Israel was able to make the transition from environmental over-exploitation, whereas the weaker and less diversified economies of Gaza and the West Bank were not. The latter are on a trajectory that indicates environmental catastrophe, unless major policy intervention takes place. This in turn cannot be done unless Israel finally relinquishes control over the West Bank (which at the time of writing it has not yet done), as it has recently done with Gaza. Israel is reluctant to do this in the case of the West Bank, because of the significance of the groundwater aquifer located there to the overall water supply of Israel.

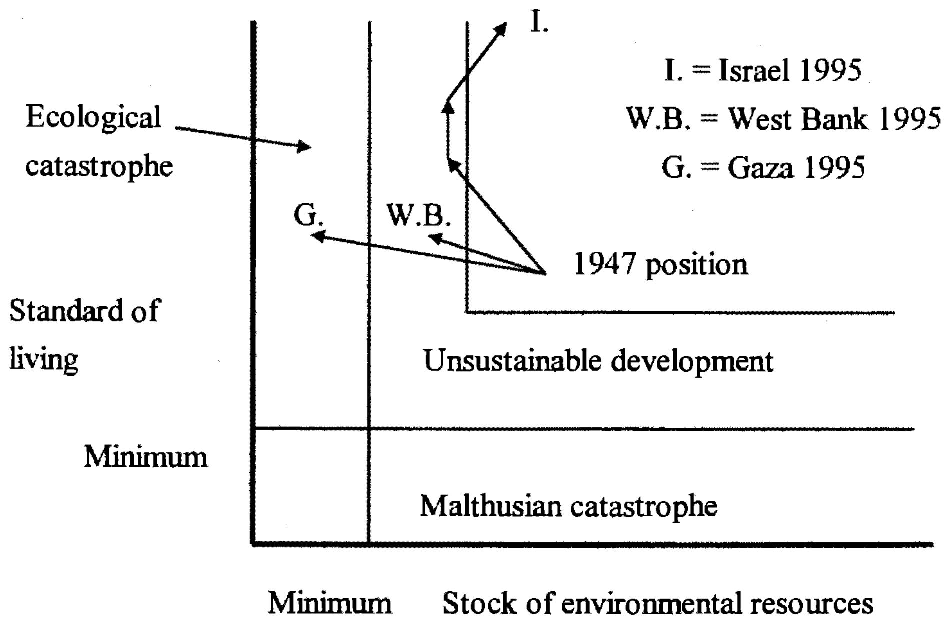


Figure 7d. The situation regarding water in Israel, the West Bank and Gaza 1947-1995 (Allan *et al.*, 1996d:127).

Allan (1996d:130) concludes that the Karshenas model shows the tendencies of economies to deplete their environmental capital during the pre-industrial phase of economic and social development. This places the water issue into perspective. In an economy where agriculture is the dominant sector of the economy, 'returns to water' will be modest. However in an industrialised economy, the 'returns to water' are high and as a result, livelihoods are more numerous. The SWE therefore becomes highly relevant in water-scarce economies. This also illustrates the need to bring economic principles to bear on matters affecting water policy, but at a rate that is consistent with the political acceptability of the approach. Policy-makers that are negotiating access to shared international water bodies, should accept that their highest priority is the creation of livelihoods. This presents the additional virtue of enabling an economy that is expanding and diversifying, to gain access to 'virtual water' on the international market.

Referring back to the example of the Great Man-Made River, the policy-maker has two broad choices if they are faced with a water scarcity. The one is to increase the supply as happened in Libya (supply side management), or one can mobilise the economy and allocate the limited water available to economic sectors that have a higher SWE, with a better 'return to water', as represented in the case of Israel (demand side management). As Allan notes (1996b), "it is much better to move the tonne of grain than the 1 000 tonnes of water if you are short of water", especially when the cereal that is available on the international market is heavily subsidised by producer governments. The case of Japan is illuminating in this regard. It has abandoned any ambitions of agricultural self-sufficiency long ago and concentrated instead on developing a strong economy, thereby enabling food to be purchased on the international market.

Finally, Allan notes (1996b) the importance of understanding the relationships of political economies to each other. To this end it is vital that the political economy of water in a country or region, is seen to be subordinate to the political economy of the global trade in cereals and hence 'virtual water'. In other words, national policies regarding water in arid regions can best be rationalised in a regional co-operative context, in order to gain the maximum benefit within the context of the regional economy; and between the regional economy and the global economy.

The need for regional co-operation brings the SADC Water Protocol into relevance within the context of the current research, as this is potentially the foundation of that co-operation in Southern Africa. This research evaluates Allan's concept in a Southern African regional context by determining which of the Zambezi Basin riparian states are potential exporters of 'virtual water' in the form of either agricultural produce or hydroelectric energy, and which are the potential importers of 'virtual water'. The critical questions that need to be asked in this regard, and which are posed at this early stage, are the following:

- Can the benefits of 'virtual water' be realised in underdeveloped countries that have no substantial industrial base?

- Will agricultural imports not create a negative balance of payments problem for developing states that are already hampered by IMF imposed economic structural adjustment programmes?

- To what extent, are the application of advanced forms of the demand side management approach that 'virtual water' trade requires, viable within a regional setting where fears exist regarding the intentions of suppliers to manipulate the recipients?

Thus, what Allan provides, is the potential solution to the hydropolitical problem that was originally identified by Falkenmark. Allan also provides a useful hydropolitical indicator in the form of the Sectoral Water Efficiency ratio. Finally, in order to achieve this possible solution, Allan highlights the need for co-operation.

Falkenmark's Water Scarcity Indicators and Water Barrier Scale

At least one of the problems being faced, is the fact that no concepts in political science can be readily operationalised into statistical indicators, to measure the political dimension of water allocation and management (Allan, 1992:379). In an attempt to address this issue some of Prof. Falkenmark's concepts are used for this research. Falkenmark, a Swedish hydrologist with an international reputation, has done considerable work in Africa. The usefulness of this work becomes apparent when one addresses the question of water scarcity. The most fundamental question to answer is whether Southern Africa is becoming increasingly arid due to climatic change, or simply undergoing a process of desiccation as the result of anthropogenic factors? The usefulness of Falkenmark's concepts is the fact that it enables a clear link to be established between population growth and water scarcity. This lends credence to the view that anthropogenic factors are significant and should be researched in greater detail, specifically when it comes to possible policy intervention.

Falkenmark (1986b:193) notes that human development can be seen as being an integral part of the hydrological cycle, also known as the "water cycle". This is enshrined in Principle 5 of the White Paper on Water Policy and is recognised elsewhere within that document (DWAF, 1997:2.2.2; 5.1.2). To this end an acceptable quality of life would not be possible without interventions in the hydrological cycle. Man should therefore be seen as one of the factors in the river basin, influencing water circulation (Falkenmark, 1979:439). Given the fact that the hydrological cycle is a constraint to the development of mankind, it is necessary to have a basic understanding of what this cycle is, especially as this concept is not one that is typically used by political scientists. In Figure 8 (overleaf), a very crude rendition of the hydrological cycle is presented (Falkenmark, 1989:112).

From this it can be seen that there is a given quantity of water that is distributed globally in a cyclic flow pattern. Essentially what happens is that water evaporates, largely from the oceans, and is distributed around the globe by winds and currents, where it falls over the continents as precipitation. Evidence of this can be found in the *El Nino* effect. Warming of the ocean surface off the west coast of South America results in alternating droughts in Africa and floods in Australia. This indicates the level of integration evident in the global weather pattern as these events are spatially separated by thousands of kilometres, yet are still causally related.

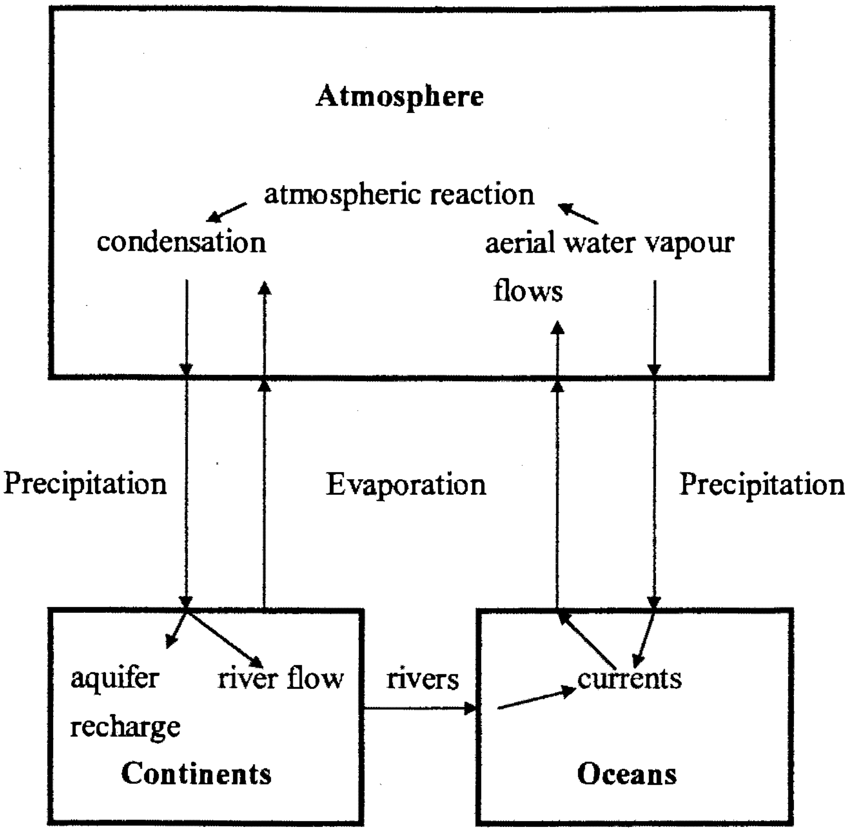


Figure 8. Basic hydrological cycle indicating cyclic nature of flow (Falkenmark, 1989:112)

What is also significant, is the fact that political concepts such as 'sovereignty', can only be applied to a portion of the overall hydrological cycle, in the sense that sovereign control of the resource is only possible while it is on the territory of the given state. Given the cyclic nature however, this is only a temporary condition. This fact contributes in part to the dilemma noted on page 23, as states try to exert control over the seemingly uncontrollable. In essence, Realism dictates actual state behaviour, whereas Idealism actually provides the best possible solution to the problem. These two poles are not always reconcilable. In this regard, it can be predicted with a high level of certainty that one of the following conditions will prevail. Water, which falls over a given state in the form of rain, will:

- eventually either flow out of the territory in a river that the given state views as its exclusive sovereign domain
- or else it will be absorbed into some aquifer under the ground

- or else it will blow away in the wind due to evapotranspiration

This is a fundamental principle of hydrology that is governed by the laws of physics and seemingly not incorporated into political science theory. This is what makes hydropolitics an approach that is more relevant than a purely political science based approach, as it seeks to integrate the advantages of two separate yet relevant disciplines. This crude hydrological cycle should be refined a little further in order to sharpen the focus of the inter-relationship of three key hydrological concepts. These are *precipitation* (usually referred to as MAP), *evapotranspiration* and *runoff* (usually referred to as MAR). This linkage is shown in Figure 9. This will be discussed more fully later in the study, where it is shown that the fundamental problem in arid regions, is the fact that the rate of evapotranspiration exceeds the rate of precipitation, thereby placing a finite limitation on purely supply sided solutions such as dams and open canals. It should also be noted that what is referred to in this study as 'supply side management' refers in part to the capture and storage of the MAR before it can flow out of the sovereign control of the given state. There is a physical limitation to the total amount of MAR that can be captured, which implies in turn that the availability of naturally occurring water within a state places a finite limit to potential economic development. The "capturing of the MAR" can at best only be a temporary condition. Evapotranspiration will return a large portion of the water to the hydrological cycle, and natural river flows will ultimately take the resource across the borders of the country, defying any long-term sovereign aspirations that the state may have.

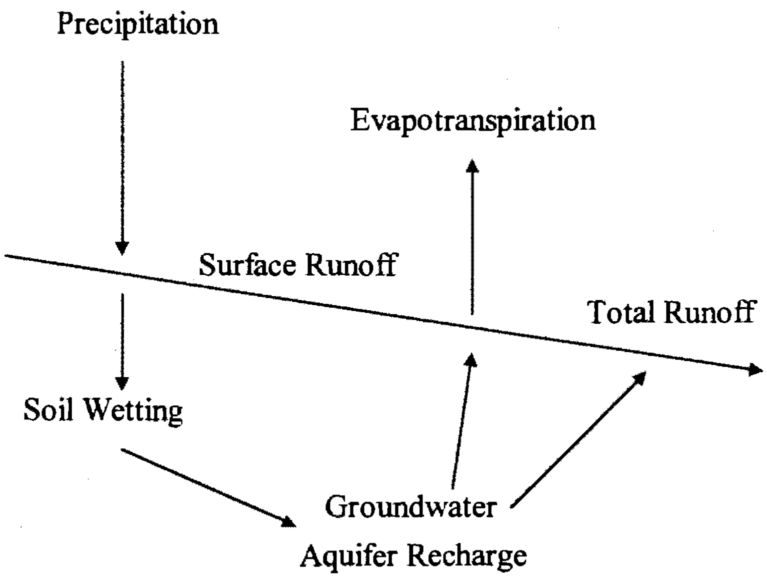


Figure 9. Local hydrological cycle showing relationship between precipitation, evapotranspiration and runoff (Falkenmark, 1986b:193).

It should be apparent that the number of persons that a given society can support is dependent on various factors such as; climate, patterns of water use, technological availability and use, and water management capacity expressed in both institutional and administrative terms (Falkenmark, 1987:191). Falkenmark (1986b:197) notes that water is a constraint to crop production as it determines the amount of biomass that a given area can produce, as well as by defining the growing season. To this end it is evident that under dry conditions, it takes approximately 1 000 m^3 of water to produce one tonne of raw biomass.

Statistical data from various countries (Falkenmark, 1986b:197) reveals the following patterns of water consumption:

- Iraq uses 4 400 m^3 / p / yr^{-1}
- Pakistan uses 2 200 m^3 / p / yr^{-1}
- Syria uses 1 300 m^3 / p / yr^{-1}
- Egypt uses 1 200 m^3 / p / yr^{-1}
- India uses 800 m^3 / p / yr^{-1}
- Israel uses 500 m^3 / p / yr^{-1}

Taking the case of Israel as an example, Falkenmark (1986b:197) concludes that a realistic level for a developing state is 500 m^3 / p / yr^{-1} as this would allow 100 m^3 / p / yr^{-1} for domestic and industrial use leaving the remaining 400 m^3 / p / yr^{-1} (80% of the total) for irrigation. By using the conversion table represented in Appendix "C" this volume (500 m^3) relates to 2 000 people / 'flow unit'. This is considered to be the 'water barrier' beyond which development is not possible under levels of currently available advanced technology. This implies that the 'water barrier' may change as new technologies become available, but these advanced technologies are normally not available to developing states. This in turn impacts on the viability of 'virtual water' as a development strategy, as developing countries typically have a limited range of technological options open to them. It also implies that in certain developing countries, where technological access is low and the population burden is high, a type of "threshold" may be reached beyond which sustainable development is simply not feasible. At this point either a Malthusian catastrophe, as conceptualised by Karshenas and used by Allan (the reader is referred back to Figure 7a on page 41 for an illustration of this), or a combination of Malthusian and ecological catastrophe, befalls the unfortunate state.

By using this statistical evidence in order to establish a base-line, Falkenmark concludes that the "hydraulic density of population", which is defined as the number of persons competing for one 'flow unit' of water ($10^6 m^3 / yr^{-1}$), is a powerful instrument for demonstrating 'water stress' and 'water competition' among countries. The concepts of 'water stress' and 'water competition' thus become fundamental in the study of hydropolitics. The above data is converted from the volume of water / person / year to the number of persons / 'flow unit' by using the conversion table presented in Appendix "C". This ultimately shows the level of 'water competition' in a given society, by equating the number of persons to the volume of recoverable resource available. A tentative water competition limit, for operating a modern society under semi-arid conditions, using extremely sophisticated water management technology, is 2 000 persons / 'flow unit' (Falkenmark, 1984:158; 1987:191; 1986b:199). Half of this value can be considered 'water stressed' for most societies.

Thus Falkenmark (1989:116) quantifies the level of 'water competition' in the states that are the subject of this study, in terms that clearly show the effect of increasing populations on the level of 'water scarcity'. These data are presented in Appendix "B" which forms the empirical foundation of this study. It should be noted that Falkenmark excludes South Africa from this data series, so the South African data is provided by Ohlsson (1995a:48). Ohlsson's data is consistent with that of Falkenmark so the use of both data sets will not jeopardise the epistemological basis of the research, as already noted during the discussion on the research design and methodology in the Introduction.

By quantifying the number of persons / 'flow unit' this allows the level of 'water competition' within a state to be measured over time. The true value of this concept is that it enables "what if" types of questions to be answered regarding population policy, and it enables a clear link to be established between population growth and water scarcity. These are clearly useful hydropolitical tools, as they provide an alternative approach that can be used ultimately to evaluate the relevance of existing state policy, which is beyond the scope of the current research. Falkenmark refines this concept by applying a known set of norms, and allocating labels to given sets of conditions (number of persons / 'flow unit') by categorising these sets on a linear scale of 1 - 5. This is termed the Water Barrier Scale (WBS) and is defined as follows:

- *Position 1* is equivalent to *well watered* conditions on the scale of <100 persons / 'flow unit'.

- *Position 2* is equivalent to conditions found in many *Mid-European* countries on the scale from 100 to 600 persons / 'flow unit'.
- *Position 3* relates to *water stressed* conditions similar to the Colorado Basin in the USA on the scale from 600 to 1 000 persons / 'flow unit'.
- *Position 4* indicates *chronic scarcity* on the scale from 1 000 to 2 000 persons / 'flow unit'.
- *Position 5* is *past the 'water barrier'* or >2 000 persons / 'flow unit'. (Falkenmark, 1989:116; 1990:181).

This can best be illustrated by using the case of Malawi (Falkenmark, 1989:113). The total recoverable resource available is 9 km^3 / yr^{-1}. The population in 1982 was 6,57 million. Projected population levels by the year 2000 are 11,67 million. By the year 2025, at current population growth rates, Malawi will have a population of 23,19 million people. This excludes refugees and any possible effects of a successful population development policy, as this would not be felt in that time frame. By combining this data, and linking the population to the volume of water available, three sets of figures are generated. These represent the number of persons / 'flow unit'. In the case of Malawi these are 730 for the year 1982, 1 300 for the year 2000 and 2 600 for the year 2025. By applying the norms provided by the WBS, it can be seen that Malawi was in Position 3 (water stressed) in 1982 and that it is likely to be in Position 4 (chronic scarcity) by the year 2000, and Position 5 (beyond the 'water barrier') by the year 2025. This provides the starting point for a useful political analysis of Malawi, by asking what the social ramifications are likely to be as the result of this interaction between hydrology and demography.

The WBS is a fundamental concept to this study, and is used in conjunction with Lowi's variables to establish an empirical basis for the understanding of the hydropolitical dynamics within the Zambezi Basin riparian states and South Africa in Chapter 3.

As noted above, water scarcity is linked to the management capacity of the state. This in turn is linked to the level of technology available. The base-line case used by Falkenmark to define the 'water barrier' was that of Israel. As indicated by Allan in the preceding section, Israel has managed the transition to that of an industrialised state, and the level of technology evident there can be regarded as high for a developing state. It can be argued that the level of technology evident in Israel is considerably higher than that available to most of the Zambezi Basin riparian states. It therefore becomes pertinent to the research to link the level of technology needed to maintain self-sufficiency, to the increasing levels of 'water scarcity' that result from rapid population growth.

Falkenmark (1989:116) accomplishes this by developing a new concept. This is called the Water Scarcity Index (WSI) and is presented in Appendix "D". What the WSI does is to take the data that is generated from the WBS analysis of a state. The position on the WBS scale of 1 - 5 for any given state, for any given year, is used to provide the second digit of a two-digit code. The first digit is provided by indicating the level of technology that is needed to maintain self-sufficiency on a linear scale of 1 - 4. This technology scale is defined as follows (Falkenmark, 1989:116; Evans, 1995:2.8; Arnestrand *et al.*, 1993:23):

- *Code 1* means that *low levels of technology* are sufficient. This implies that rainfed agriculture is largely adequate with limited irrigation required.
- *Code 2* means that *intermediate levels of technology* are sufficient. This implies that rainfed agriculture is no longer sufficient, and that limited water transfer schemes may be considered relevant.
- *Code 3* means that *high levels of technology* are sufficient. This implies that large water transfer schemes and limited IBTs are needed.
- *Code 4* means that *large-scale irrigation* and very high levels of technological input are needed. This implies very complex sets of IBTs and related water transfer schemes, which are both technologically and capital intensive and therefore beyond the reach of most developing states.

This is best illustrated by using the above example of Malawi. From the WBS analysis conducted above Malawi had the following results:

- 1982 = Position 3
- 2000 = Position 4
- 2025 = Position 5

The second WSI digit for each year comes from the above WBS analysis, and the first is allocated by Falkenmark after determining the level of technology that will probably be needed to maintain self sufficiency. Falkenmark (1989:113) concludes that Malawi has the following positions on the WSI index:

- 1982 = 13
- 2000 = 24

- 2025 = 25

This WSI code is interpreted against the norms provided for by both Appendix "D" and the HPRP values defined on page 16 of the Introduction. These are as follows:

- 11 & 12 is a low HPRP
- 21, 22 & 31 is a medium HPRP
- 13, 23, 24 & 32 is a high HPRP
- 25, 33, 34 & 44 is a very high HPRP

Thus for the case used as an example, it can be seen that Malawi had a high HPRP profile already in 1982, and that by the year 2025 this will become very high. The implications are therefore that Malawi is unlikely to manage to develop the levels of technology needed, and that self-sufficiency will not be achievable. This in turn implies that Malawi is likely to become an unstable state, which is likely to affect other states in the region by monopolising scarce regional resources and providing a significant source of economic or environmental refugees. It can therefore be concluded that Falkenmark provides a useful analytical tool for hydropolitical analyses to be made. This is also the reason why other data on South Africa cannot be used, as Falkenmark allocates the first digit of the WSI. For meaningful analysis to be made, this allocation needs to be consistent. This supports the argument used to justify the selection of data in the discussion of the methodology presented in the Introduction.

Finally, Falkenmark (1977:7) provides one more useful concept to show how riparians are linked within the hydrological cycle. This is presented in Figure 10 overleaf. This indicates the fact that a given consumer uses the water abstracted from surface water (river) flows. A certain amount of this water is lost, with the remainder being returned to the hydrological cycle as effluent (whether treated or raw). This shows how an upstream riparian is in a superior position as the volume of water is higher, and the quality is better as each time the water is used, treated and returned to the river, there is a loss in overall quality. In some developing states, the treatment of effluent is not always to an acceptable level, before the water is returned to the river. (This is evident for example in the Zambezi Basin just above Batoka Gorge where the author has personally noted the direct discharge of near-raw sewage directly into the river). It should be noted that agricultural use of water for irrigation also returns water to the hydrological cycle. This is done in the form of either evapotranspiration, surface runoff or groundwater recharge. The implications are that other agricultural inputs such as fertilisers and pesticides leach into the surface and groundwater portions of the cycle causing salinity build-up, chemical contamination and eutrophication, which become a problem for lower order riparians to contend with. This is also evident with industrial discharge. The Kafue River discharges heavy metal contamination originating from the copper mines into the Zambezi River as an example. An interesting point to note is the fact that instream use is depicted. In modern thinking where sustainability is a key factor, river biotic systems are regarded as legitimate consumers of their own water. For example, South African water law enshrines this under principle C.4 and refers to it as part of "the reserve", which enjoys priority of use (DWAF, 1996:6). It is also found in Principle 9 of the White Paper on Water Policy (DWAF, 1997). This implies that a certain minimum fluvial flow rate is regarded as being necessary for maintaining the ecological viability of the river, and hence the long-term sustainability resulting from abstraction.

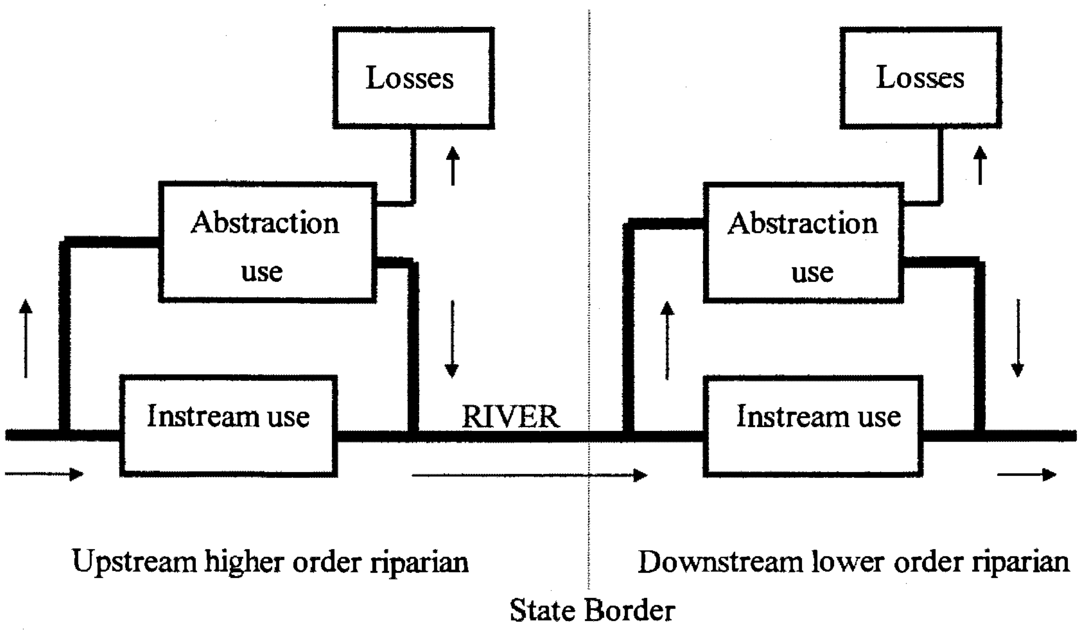


Figure 10. Schematic representation of the relationship between upstream and downstream riparians (Falkenmark, 1977:7).

Thus it can be seen that there is a global pattern to water related problems which are manifest in hydropolitical dynamics. These can be categorised into the following (Falkenmark, 1977:7); *quantity problems* (water supply, storage, evaporation and seasonal fluctuation), *quality problems* (pollution, salinity and eutrophication), and *disease problems* (gastro-intestinal diseases, schistosomiasis, malaria etc.) These are linked in hydropolitical terms between states as the result of the universal nature of the hydrological cycle, and the basic role of water as a carrier of nutrients and pollutants within the ecosystem. It can also be seen that the amount of recoverable water resources available to a state, are the sum of the inflow to the state from shared rivers, and the total MAP and MAR available. If the total recoverable resources of each riparian state are added up, it will be found that the sum exceeds the total volume of the river, as the water flowing out of one state becomes the inflow to the next and is thus counted twice. This accounts for some of the variation in data regarding the volume of recoverable water resources available. This again justifies the criteria imposed on data selection as stipulated in the Introduction under the heading of "Research Design and Methodology".

SADC Protocol on Shared Watercourse Systems

As noted by Allan, in order to benefit from a 'virtual water' development strategy, a high level of co-operation is required between states. Historically, within the Southern African setting, co-operation has not been co-ordinated regionally. This should change with the implementation of the SADC Water Protocol, which was adopted in August 1995 (Pitman *et al.*, 1997:144) prior to South Africa becoming a member. Given the fact that the Protocol on Shared Watercourse Systems in the Southern African Development Community (SADC) Region is often referred to in this research, it is considered to be prudent to briefly present the key issues that this Protocol covers.

The SADC Water Protocol places the responsibility for co-operation between states within a basin on the states themselves (Pitman *et al.*, 1997:144). Three levels of institution are to be established. Firstly, at the level of government, states should agree on the sharing of common water resources. Secondly, at the basin level, a commission should be established. Thirdly, there should be co-operation between river authorities, boards or utility companies. The Zambezi River was chosen by SADC for a pilot study. In 1987 the Zambezi River Action Plan (ZACPLAN) was established. This consists of 19 projects, called ZACPRO 1-19, all of which fall under ZACPLAN. ZACPRO 2 was the project that led to the establishment of the Protocol for the whole of SADC, and not just within the Zambezi Basin.

Article 2 of the Protocol lays out the following general principles:

- The utilisation of shared watercourse systems within the SADC region is open to each riparian or Basin State within its territory without prejudice to its sovereign rights.

- The general rules or customary international law relating to the utilisation and management of a shared watercourse system, particularly that regarding equitable utilisation, are to be applied.
- A proper balance is to be maintained between resource development and conservation. The concept of 'sustainability' is enshrined.
- Close co-operation regarding the study and execution of projects that are likely to impact on the regime of the watercourse system is to be undertaken.
- An exchange of data regarding relevant aspects that impact on the condition of the watercourse system is to be encouraged.
- Equitable use is enshrined as a basic principle.
- Discharge of waste into the system is to be governed by a permit system.
- In the event of an emergency emanating from a Member State, all potentially affected states must be notified of the circumstances relating to the emergency.
- The introduction of alien aquatic species into the system is to be prevented, as is pollution and environmental degradation.
- Shared watercourse systems can only be used for peaceful purposes in keeping with the SADC Treaty and the Charter of the United Nations.

Article 3 of the Protocol defines the establishment of River Basin Management Institutions as follows:

- Member States undertake to establish "appropriate" institutions necessary for the effective implementation of this Protocol.
- A Monitoring Unit is to be based at the SADC Environment and Land Management Sector (ELMS).
- River Basin Commissions between Basin States and in respect of each river basin are to be established.
- River Authorities or Boards are to be established in respect of each river basin.

Article 4 of the Protocol defines the objectives of the River Basin Management Institutions as follows:

- The development of a monitoring policy.
- The promotion of the equitable utilisation of the shared system.
- The formulation of strategies for the development of the shared system.

- The monitoring of the execution of integrated water resource development plans for the shared system.

Article 5 of the Protocol defines the functions of the River Basin Management Institutions as follows:

- The harmonisation of national water resource policies and legislation.
- Monitoring of the compliance to water resource legislation with amendments being recommended where necessary.
- The collection, storage, analysis and dissemination of data relevant to the integrated development of the resource.
- The review of National Development Plans.
- Designing of relevant research programmes.
- Promotion of the formulation of integrated master plans for the shared system.
- Water control and utilisation aspects such as flow regulation, flood mitigation, erosion, siltation and the monitoring of hydroelectric installations.
- Environmental protection by means of the control of substances whose introduction to the system should be banned or controlled.
- Establishing a hydrometeorological monitoring programme.

Article 6 of the Protocol notes that the financial and regulatory framework for River Basin Management Institutions shall be annexed to the Protocol as it is not yet finalised. This hampers the implementation of the Protocol, as without a budgetary base, the institutional structures cannot be effectively established. This is seen as a serious flaw in the Protocol as it undermines the institutional capacity.

Article 7 of the Protocol notes the following regarding the settlement of disputes:

- Any dispute between two or more Member States that arises from the interpretation or application of the Protocol shall be referred to the Tribunal for adjudication under Article 16(1) of the SADC Treaty, unless it can be settled amicably.
- If a dispute pertaining to the Protocol arises between SADC and a Member State, the Council shall make a request for an advisory opinion in accordance with Article 16(4) of the SADC Treaty. The parties concerned shall accept the opinion so obtained as binding.

Article 12 of the Protocol notes that an amendment to the Protocol shall be adopted by a decision of three-quarters of the Summit members who are party to the Protocol.

Article 13 of the Protocol allows Member States to withdraw upon the expiry of six months after written notification to this effect has been given to the Executive Secretary.

Article 15 notes that nothing contained in this Protocol shall derogate from existing agreements between Member States, or between a Member State and a non-member state.

It can thus be seen that the Protocol provides a useful instrument for co-operation in the water field, but that the absence of financial resources hampers the effective implementation of the agreement at this stage. It has the potential to foster future co-operation, but this will not be automatic. It will probably fail if it is not supported with the relevant political will. Significantly, if a non-riparian state wishes to negotiate access to a given river system, it will have to negotiate with all of the riparian states in the basin in terms of Article 2.7(c). This opens the door to diplomatic lobbying, especially for the support of riparian states that may seek to maximise their advantage by co-operating with a hegemonic power. The Protocol is not clear as to what would happen if the majority of the riparian states within a given basin agreed to allow a non-riparian access, while another riparian state refused.

Conclusion

It can be concluded that the highly specific nature of the interaction between unique variables inherent within any study of hydropolitics implies that conventional concepts from the discipline of political science are not always adequate. To this end the interaction between hydrology and politics is highly relevant, with hydropolitics attempting to explain and predict the socio-political results of a certain set of hydrological factors. This can only be fully understood within the context of political economy however. For this reason it has been necessary to make use of three distinct but inter-related sets of concepts:

- Lowi's theory of hegemonic co-operation.
- Allan's concept of 'virtual water' and the significance of SWE in relation to the stage of development within a state.

- Falkenmark's concepts relating to the hydrological cycle, WBS and WSI.

It is illuminating to note that the word 'rival' comes from the Latin word 'rivus' which roughly means to share a river (Financial Mail, 1/9/95:23). This has increasing significance in Southern African terms when one considers the visit in July, 1996 by the South African Minister of Water Affairs and Forestry, Kader Asmal, to Washington where he was looking for support for South Africa's "looming water crisis". This support involves funding for a major IBT from the Lualaba River (in the headwaters of the Zaire (Congo) River Basin), via the Zambezi River and a man made aqueduct through Botswana into the industrial heartland of the region - Gauteng (Africa Analysis, 26/7/96:14). As Davies *et al.*, (1993:143) conclude, "it is only a matter of political resolve, and funds, before the execution of such transfers will take place - for example, bringing the impounded waters of the Zambezi into this developing network". Should this proceed, it will involve complex political negotiations involving the riparian states of both the Zaire (Congo) and Zambezi River Basins. This is more likely to take place now that the Democratic Republic of Congo is a member of SADC, as it could offer this resource to other Member States in return for economic and infrastructural development.

It is deemed significant that the Protocol on Shared Watercourse Systems in the Southern African Development Community (SADC) Region was adopted shortly before South Africa became a member. Now that South Africa is a member, it will be interesting to note to what extent it will play the role that is consistent with Lowi's (1990:386) view that co-operation is not achieved unless the dominant power in the basin accepts it, and even enforces compliance to the rules so created. The political significance in this context being that South Africa is not a legitimate riparian state in the Zambezi Basin, but possibly intends to gain access to the waters thereof in the near future. For South Africa, Zimbabwe, Namibia and Botswana, this issue is likely to become one of 'high politics' very soon. It is therefore argued that the Protocol can be a useful instrument in the hands of a state that intends to gain access to new water from outside their own borders. If Lowi's theory is relevant, this Protocol will not lead to the establishment of a basin wide regime unless South Africa, as the regional hegemonic power, benefits.

The hydropolitics of Southern Africa are beginning to be felt in the region. To conclude this portion of the review, it should be noted that an important aspect of water planning and water resources research is to be aware of the potential conflicts, and to devise ways of alleviating or preventing them in the first place (Widstrand, 1980:121).

CHAPTER 2

DISCUSSION OF LITERATURE RELATING TO THE SUBPROBLEMS

Introduction

Having noted the theoretical relationship between hydrological factors and the resultant socio-political dynamics that arise, it now becomes necessary to review the general literature concerning the four subproblems. This review is necessary in order to establish whether there is in fact an inter-relationship between the subproblems, and if so, what the nature of that relationship is. From this general literature it will be determined if the solutions proposed by the respective authors involve functional co-operation as hypothesised. This will lay the foundation for a more detailed analysis of the individual Zambezi Basin states and South Africa in Chapter 3. The important question to answer at this stage is, if functional co-operative solutions are being offered by the authors consulted, what is the likelihood of this co-operation actually materialising within Southern Africa? Stated differently, if functional co-operation seems to be the most appropriate option for a developing state, what are the factors that are most likely to either contribute towards or mitigate against such an option?

An overview of Literature Related to the 'Increasing Water Scarcity' (First Subproblem)

Myers (undated:18-9) notes that as many as 80 countries, containing two-fifths of the global population, already suffer serious water deficits. Not a single government in the Sahel region of Africa survived the droughts of the 1970s and 1980s, with several falling twice. Southern African countries face inadequate water supplies, because global warming is predicted to increase aridity over most of the African continent (Mac Donald *et al.*, 1990a:2.1).

Falkenmark (1990:181) brings the problem closer to home by attempting to quantify the projected water scarcity in Southern Africa by the year 2025. This is done by using the WBS. This indicates the projected worsening of the water availability position of most Southern African states over time. Using this scale, Falkenmark (1990:182) categorises the Zambezi Basin in Table 2. From this it is evident that all states move into a progressively worsening situation. The case of Zimbabwe, Tanzania and Malawi should be specifically noted, as they are all predicted to move into a precarious position by the year 2025.

TABLE 2

FALKENMARK'S PROJECTION OF ZAMBEZI RIVER RIPARIAN STATES
in Relation to the WBS over Time.

WATER BARRIER SCALE	1982	2025
1 Well watered	Zambia, Botswana, Angola	
2 Mid-European	Mozambique, Zimbabwe, Tanzania, Namibia	Zambia, Botswana, Angola, Namibia
3 Water stressed	Malawi	Mozambique
4 Chronic scarcity		Zimbabwe, Tanzania
5 Past 'water barrier'		Malawi

Unfortunately the above table does not show the position of South Africa. Falkenmark (1990:182) shows the position of the Limpopo Basin in Table 3. This indicates the worsening position of South Africa, which is not a Zambezi Basin riparian.

TABLE 3

FALKENMARK'S PROJECTION OF LIMPOPO RIVER RIPARIAN STATES
in Relation to the WBS over Time.

WATER BARRIER SCALE	1982	2025
1 Well Watered	Botswana	
2 Mid-European	Mozambique, Zimbabwe	Botswana
3 Water stressed	South Africa	Mozambique
4 Chronic scarcity		South Africa, Zimbabwe
5 Past 'water barrier'		Nil

Although the Limpopo Basin is excluded from the research, the data is included here as the riparian states are all part of the Zambezi Basin (with the exception of South Africa) and thus shows the relationship between South Africa and the rest of states in the area of study. This data for South Africa from Falkenmark, corresponds with that portion of the WSI that is derived from the WBS, and which is used by both Arnestrand *et al.*, (1993:24) and Ohlsson (1995a:48). This validates the criteria for data selection as presented in the discussion of the research design and methodology in the Introduction.

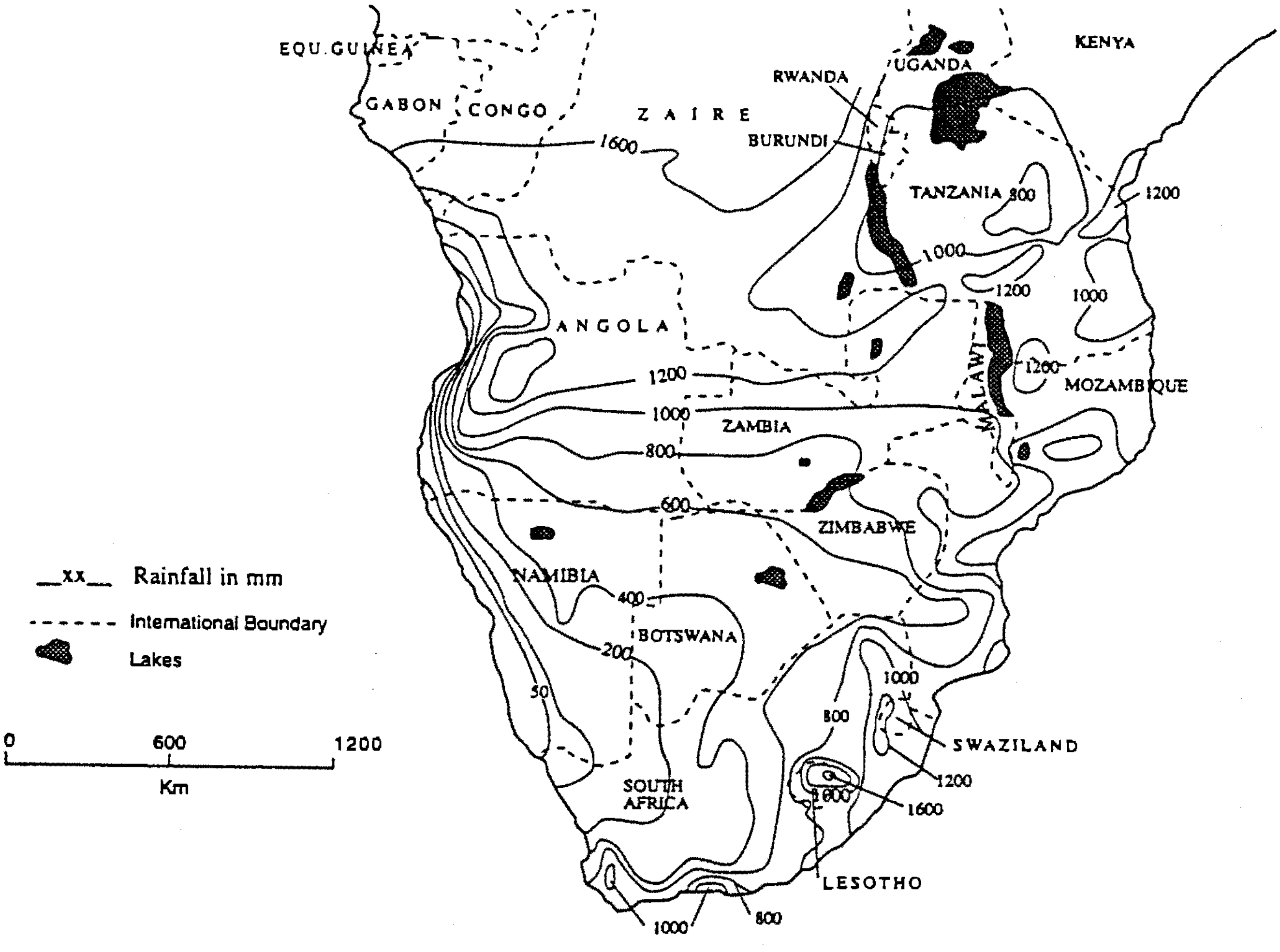


Figure 11. Annual precipitation over Southern Africa (Arnestrand *et al.*, 1993:7).

Figure 11 shows the precipitation levels over Southern Africa. In the Southern African region, the following climatic zones are found (Conley, 1996c:22):

- 7% of the area is desert with 100mm of rain per year
- 15% is arid with 100 - 400mm of rain per year
- 16% is semi-arid with 400 - 600mm per year
- 19% is sub-humid with 600 - 1 200mm of rain per year
- 40% is moist sub-humid with 1 200 - 1 500mm of rain per year
- 3% is humid with more than 1 500mm of rain per year

A significant point is the fact that South Africa accounts for some 80% of the total regional water use, with only 10% of the total water resource being available in that state (Conley, 1996c:26). This illustrates the dramatic potential for politicisation of issues related to access to shared watercourses in the region, particularly when one considers the coincidence of South Africa's hegemonic status and pressing need for reliable access to water in future. This is analysed in more detail later in the study. The industrial heartland of the Southern African region is South Africa, yet available water resources for this state are likely to be depleted within the next 15 years (Financial Mail, 1/9/95). Falkenmark (1989:113) quantifies the projected regional problems by linking recoverable water resources to population projections by means of the WBS. This enables relative competition dynamics to be calculated over time. The population data from Table 6 (on page 72) is linked to the amount of recoverable water (km^3 / yr^{-1} converted to 'flow units') from Appendix "B", which results in a projection of 'water competition' as measured on the WBS. These figures form the empirical basis of the research regarding the Zambezi Basin states and is shown in Table 4a. This data clearly shows the progressive worsening of the position of most of the states over time. It can also be seen that competition for water as a basic resource is increased as the result of rapid growth in population.

As previously discussed, it should be noted that Falkenmark has not given complete WBS statistics for South Africa. All that is available is the WSI portion of the WBS data for South Africa, which was presented in Table 3. Complete data has fortunately been provided for South Africa by Ohlsson (1995a:48) which is presented in Table 4b. The combined statistics from Falkenmark, Arnestrand *et al.*, and Ohlsson are presented in Appendix "B" and Table 6 on page 73. This forms a complete data set for 2025. This is used extensively in Chapter 3 for a detailed analysis if each individual state.

TABLE 4a

FALKENMARK'S COMPUTATION OF WATER COMPETITION
for Southern Africa based on the WBS
indicating the impact of population growth on 'water scarcity'

COUNTRY	VOLUME (KM^3/YR^{-1})	WBS 1982	2000	2025
Angola	158	47	84	160
Botswana	9	96	210	450
Malawi	9	730	1 300	2 600
Mozambique	58	190	380	690
Namibia	9	120	260	480
Tanzania	76	250	520	1 100
Zambia	96	60	120	250
Zimbabwe	23	350	660	1 400

(*) As noted in the Introduction, Falkenmark excluded South Africa.

TABLE 4b

OHLSSON'S COMPUTATION OF WATER COMPETITION
for South Africa (*) based on the WBS
indicating the impact of population growth on 'water scarcity'

COUNTRY	VOLUME (KM^3/YR^{-1})	WBS 1990	WBS 2025
South Africa	50	741	1 419

(*) As noted in the Introduction, Falkenmark excluded South Africa.

Myers (1989:216) notes that,

> "even with high-level agronomic inputs in the form of water-efficiency systems, the water stressed countries are projected to include ... Tanzania, Malawi, Zimbabwe and Lesotho, with a total of 215 million people today; by the year 2025 virtually all of these countries are projected to suffer from *absolute scarcity of water*" (emphasis added).

SADC hydrological consultants Sir M. MacDonald & Partners Ltd., (1990a:2.28) use Falkenmark's WSI as an analytical tool (refer to review of literature under agricultural capacity). Using these indicators, along with Falkenmark's standard 'flow unit', they prepared a table showing the projected 'water scarcity' for SADC Countries. The level of water competition is expressed as persons / 'flow unit'. The reader is referred to Appendix "B", which is a partial reproduction of this table and Table 7 (on page 76), which forms an empirical basis for this research. It is illuminating to note that Lesotho, which is currently being used as the source of the Gauteng water shortfall via the LHWP, actually has the lowest amount of recoverable water of all Southern African states (Falkenmark, 1989:113; Ohlsson, 1995a:48). Lesotho falls behind Namibia and Botswana that both have a low MAP (but are sparsely populated), and Malawi which is densely populated but experiencing a higher MAP.

A special point that deserves to be mentioned is the highly stochastic nature of the flow pattern, which is typical of rivers in the region. Bannink (1996:6) notes for example that a ten year study done in Zambia, indicated that for the month of January, 95% of the recorded precipitation values are expected to lie between zero and four times the monthly average, while in other months this range is even larger. The Zambezi River average flow rate at Katima Mulilo is 41 km^3 / yr^{-1}, but this average figure hides the real situation - average November flow is about 300 cumecs, increasing to 3 800 cumecs in April. To illustrate the point better, if each of these momentary flows were to continue for one year, they would result in an annual flow of 9 km^3 / yr^{-1} and 114 km^3 / yr^{-1} respectively (Ohlsson, 1995a:39). Davies *et al.*, (1993:23-25) use words such as "variability", "unpredictability" and "extremely erratic" to describe the 'normal' stream flow patterns in the region. These researchers even suggest that;

> "the subcontinent is *not experiencing a decrease in rainfall* nor, as a consequence, 'progressive desiccation' ... thus, other causes must be investigated for the obvious desert encroachment from west to east within the area ... (and) human influences are almost certainly implicated".

This point is also stressed by the World Bank (1992:3.7) which states that there have been "large shifts in annual flow which have been evident since measurements were first taken in 1906". They quote Zambezi River flow variations at Kariba as follows:

- 1924-47 mean flow = 34,1 billion m^3 / yr^{-1}
- 1947-81 mean flow = 48,33 billion m^3 / yr^{-1}
- 1981-91 mean flow = 29,0 billion m^3 / yr^{-1}

The World Bank (1992:3.7) conclude that,

> "the dramatic reversal in (Zambezi River) flow in 1981 raised serious questions as to whether there was adequate river flow to justify an increase in (electricity generating) plant capacity at Kariba. ... Annual power generation had to be reduced by up to 20% during the 1980s to prevent Lake Kariba levels from falling below the minimum turbine level".

An alarming fact concerning Lake Kariba is that the level has shown a steady cyclic decline, with a minimum recorded on 29/1/85. The significance is that for every one metre of extra depth gained (termed 'head' in engineering parlance), turbine efficiency is increased by 0,7% (Dale, 1992:9). In 1992 the water level in Lake Kariba was less than 0,5m above the minimum turbine level (Arnestrand *et al.*, 1993:34). Lower water levels thus mean increased inefficiency of current electricity generation, while illustrating the long-term difficulty of developing such unpredictable resources. This indicates that the development of the Zambezi River presents a set of complex problems, which need to be solved in order to avoid running the risk of collapse during normal drought periods, with potentially catastrophic economic and political repercussions. This problem will be exacerbated if the waters of the Zambezi River become increasingly exploited for irrigation purposes to feed the growing population.

Gleick (1993:101) introduces an important point, namely that South Africa had a water availability of 1 420 $m^3 / p / yr^{-1}$ in 1990, which is projected to decrease to 790 $m^3 / p / yr^{-1}$ by the year 2025. Lesotho on the other hand had a water availability per capita of 2 220 $m^3 / p / yr^{-1}$ in 1990, which is projected to decrease to 930 $m^3 / p / yr^{-1}$ by the year 2025. This again illustrates the long-term problem of using Lesotho as the source of the water deficit for Gauteng in the form of the LHWP, as Lesotho is projected as going beyond the critical threshold of 1 000 $m^3 / p / yr^{-1}$. This is recognised as the minimum water requirement for an efficient, moderately industrialised state. Some researchers (Widstrand, 1980:176) already note that, "Lesotho has long passed the point of no return".

It can thus be said, that even though the LHWP is a massive engineering project, it can at best be seen as an interim solution only. It can only buy time in order for a more viable long-term solution to be developed. Large scale IBTs are therefore not necessarily a long-term solution, and the proposed Lualaba-Zambezi-Botswana-Gauteng IBT (referred to alternatively as the Zambezi Aqueduct (Ohlsson, 1995a:54) and the South African Water Transfer Scheme (Arnestrand *et al.*, 1993:28)) may create more problems in the long run than it intends to solve. This also serves to indicate the state of confusion in the literature as the 'flow unit' chosen by Gleick is 1 000 m^3 / yr^{-1}, whereas Falkenmark chooses a figure of one million m^3 / yr^{-1}. (For the purposes of this research Falkenmark's 'flow unit' will be accepted, with Gleick's data used simply to illustrate the specific case of Lesotho as it is omitted from Falkenmark's data set, because it is on neither of the two drainage basins mentioned).

The solutions are hampered by the problem of high evaporative losses inherent in arid regions, which impacts heavily on the choice of supply side options available. A major political consequence of this is the fact that as a result of high evapotranspiration, a sizeable portion of the available water in most Southern African states comes from rivers originating outside that country (Ohlsson, 1995a:8). SADC hydrological consultants, Sir M. Mac Donald and Partners, Ltd., note (1990a:2.7) that evaporation from Lake Kariba alone accounts for almost 20 - 25% of the annual flow of the Zambezi River at that point. Evaporative losses from the Vaal Dam in Gauteng exceed precipitation every month of the year (Davies *et al.*, 1993: 142). Evaporative losses from the Omatako Canal, a component of the ENWC in Namibia, account for 70% of the water carried by the scheme at that point (Davies *et al.*, 1993:168). The Omatako Canal may in future be extended to abstract water from the Zambezi River (Ngipandulwa, 1996), which means that even greater evaporative losses will result. More than one quarter of the average inflow of Maputo's main reservoir, Pequenos

Limbombos, evaporates (Ohlsson, 1995a:37). Table 5 shows a version of the Zambezi River water balance quoted by Bannink (1996:3). Attention is drawn to the magnitude of the evapotranspiration loss (abbreviated as "evapo-transp") when compared to precipitation (abbreviated at "precip").

TABLE 5

ZAMBEZI RIVER WATER BALANCE

SECTION	AREA KM^2	PRECIP $10^9 M^3 / YR^{-1}$	EVAPO-TRANSP $10^9 M^3 / YR^{-1}$	RUN-OFF $10^9 M^3 / YR^{-1}$	ANNUAL MEAN FLOW M^3 / S
Upper	320 000	360	245	49,2	1 240
Middle	798 000	470	443	25,6	2 700
Lower	282 000	487	312	31,6	3 500
Total	1 400 000	1 317	1 000	106,4	6 440

The implications of the empirical fact that Southern Africa experiences high evaporative losses (2 250 - 3 000 mm per annum), are that the construction of large dams and open canals, as components of supply side management solutions in arid regions, are not always a viable long-term option. As a rough indicator of this problem, most of the water for South Africa comes from rivers fed by a MAP of less than 470 mm / yr^{-1} (Financial Mail, 1/9/95:20), whereas the high evaporative losses mentioned above are generally experienced. Stated bluntly, the evaporation rate exceeds the precipitation rate in arid regions. This is the basis of the hydrological problem, which in turn forms the basis of the socio-political problems. Figure 12 (overleaf) shows the evapotranspiration for the region.

Solutions defy the traditional political paradigms and the direct importation of technologies or ideas from the wetter Northern Hemisphere are not always appropriate (Falkenmark, 1989:113; 1979:442). The water scarcity is considered endemic even during a 'normal year' and the extent of the problem is growing (Arnestrand *et al.*, 1993:13). As Renner *et al.*, note (undated:122), the concept of 'absolute sovereignty' is no longer workable in this regard. Environmental security depends on international co-operation. This is possibly the first step to finding an effective solution. Falkenmark (1986a:85) is adamant that a secured water supply is the cornerstone of any national planning strategy, especially in arid regions. The problem of 'water scarcity' is thus shared by all, and all of the people living in a given drainage basin are mutually interdependent (Widstrand, 1980:9) across international borders. It is now accepted that entire river basins should be used as a unit of management under some form of legitimate 'catchment management authority' (Davies *et al.*, 1993:199). This principle is also enshrined in International Law as part of the Helsinki Rules (Maluwa, 1992:34), and is encapsulated in the SADC Water Protocol. It is also enshrined in Principle 5 of the White Paper on Water Policy for South Africa while being entrenched elsewhere in that same document (DWAF, 1997:6.9.1; 7.2.4; 7.2.5).

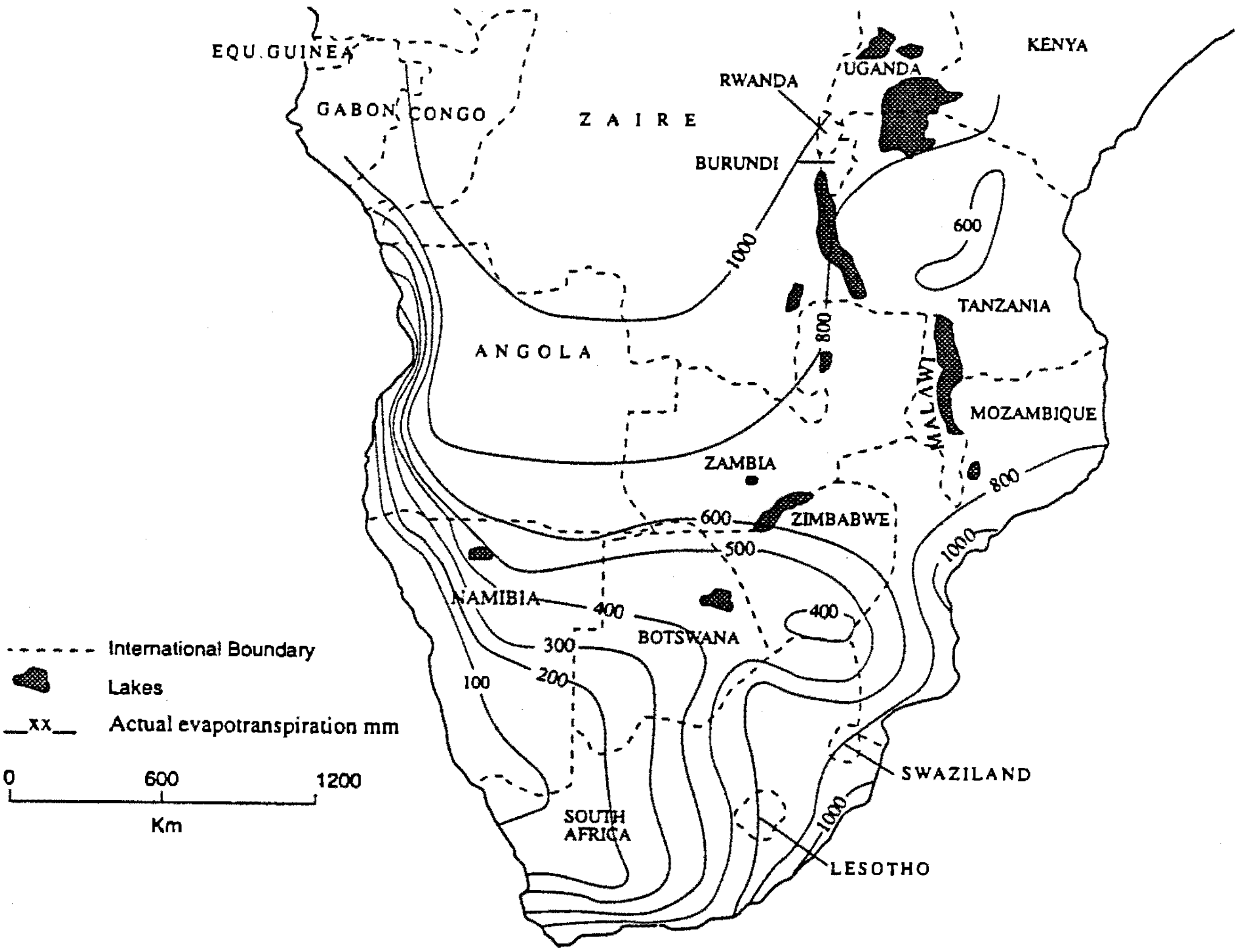


Figure 12. Annual actual evapotranspiration in mm (Arnestrand *et al.*, 1993:8).

In conclusion, Fox *et al.*, (1979:18) are of the opinion that the international community should continue to build a consensus as to what constitutes an equitable division of the benefits and costs resulting from the development and use of international water resources. Regional co-operation based on the concept of 'virtual water', with its inherent equitable distribution of both costs and benefits, is thus potentially a viable solution. Significantly, the principles on which a 'virtual water' development strategy is based, form the foundation of the White Paper on Water Policy for South Africa (DWAF, 1997:2.2.1; 6.6.2). They are entrenched as Principles 7, 12 & 13 and they impact fundamentally on the policy direction that will be taken by the regional hegemon into the next century. This concept is important because it allows the 'virtual water content' of a commodity or service to be moved, normally via trade, without the encumbering volume of actual water needed to produce them. This is particularly important for those attempting to understand or explain the political economy of water in arid regions (Allan, 1996a), and enables supply side solutions like IBTs to be re-evaluated.

An Overview of Literature Related to 'Population Growth' (Second Subproblem)

USAID Administrator, Brian Atwood, recently said (Ohlsson, 1995a:3) that:

> "disintegrating societies and failed states with their civil conflicts and destabilising refugee flows have emerged as the greatest menace to global stability. ... The pyre of failed states is fuelled by ... endemic poverty; rapid population growth; food insecurity; environmental degradation; and unstable and undemocratic governments".

Myers (undated:22) alludes to the point that the biggest factor of all in many developing countries is the population growth pattern, which for many states is still to enter the most explosive phase. Buzan (1991:93) notes that a:

> "more complex threat to population can arise from human migrations. This threat works primarily at the societal level, especially when the incoming population is of a different cultural or ethnic stock from those already resident. It can also work in the economic and environmental sectors if newcomers overburden a fragile environment or compete for scarce resources in marginal desert lands."

This uncontrolled exponential growth and movement of the human population places pressures on the economy, agricultural capacities and water resources. This can lead to the types of conflict identified by Homer-Dixon (1994), but more typically of the group-identity and relative-deprivation types. Water scarcity in developing countries from arid regions, amounts to a general constraint on development, and cannot be treated separately from population development strategies (Ohlsson, 1995a:2). Empirical evidence exists that environmental degradation, accentuated by population growth and poverty, can trigger mass migrations of people unable to sustain themselves in their countries of birth (Myers, undated:27). Within Southern Africa, the migration of drought affected refugees from Mozambique to Malawi and Zimbabwe in 1992 is a recent example (Arnestrand *et al.*, 1993:13).

The competition for water is at its most intense in arid drainage basins that also have rapid population increases (Falkenmark, 1986:97) and the highest level of conflict as a result of this can be expected to emerge from Africa (Falkenmark, 1986:109). In fact it is significant that it is among the developing countries that all violent conflicts involving a population factor have taken place (Leroy, 1986:173). As Falkenmark (1990:188) notes, one problem of special relevance to future research, is the severe water scarcity that will develop in response to population growth, where this scarcity is likely to pose a "massive threat" to the semi-arid regions where many river systems are shared between several countries.

Ohlsson (1995a:7) quantified this in a recent SADC study, which shows that by the year 2025, both Malawi and Tanzania will fall below the critical benchmark of 0,07 hectare of cropland per capita, to be joined in 2050 by Lesotho, Mozambique and Swaziland. This benchmark is considered an important threshold beyond which countries cannot support themselves without dependence on increasing inputs of both fertilisers and irrigation. The significance of this benchmark to a discourse based on the rationale of 'virtual water', is that the economies of certain of the countries in Southern Africa are based on a subsistence type of agriculture. This in turn means that when the majority of the population is no longer able to feed itself, they migrate to perceived "greener pastures". Thus the more developed economies, which can possibly benefit from a 'virtual water' based approach, become burdened by an unplanned external developmental inhibitor. This will be analysed more fully in Chapter 3. Population growth within Southern Africa is thus causally linked to both water scarcity and land availability in Ohlsson's study.

Leroy (1986:166-168) suggests a model that illustrates the impact of population growth on international relations. The important point to note, is that this model tries to explain that international repercussions of population-resource shifts in certain countries, can only be fully appreciated when comparing them to the other states in the same competitive system (Leroy, 1986:169). The regional grouping of states thus becomes important, when all of the states are facing similar problems.

The main impact of a rapidly growing population on water resources, is that it reduces the freedom of choosing between available options, by decreasing the available water on a per-capita basis (Falkenmark, 1986:85). In the case of the Southern African region, it is noted that the population of most states is likely to double in the next 20 - 30 years (MacDonald *et al.*, 1990a:2.1). This introduces a sense of urgency to the problem, as this time frame will take some countries beyond the 'water barrier' from where recovery with current levels of technology is unlikely. As both MacDonald *et al.,* (1990a:2.23) and Arnestrand *et al.,* (1993:21) soberly warn, the inevitable population increases in sub-Saharan Africa are therefore likely to impose a severe strain on water resources in the next two decades *irrespective* of any dramatic decrease in fertility rates, which shows little chance of occurring in the present circumstances anyway. In fact Southern Africa, with only some 2% of the global population, is expected to contribute about 6% of the global population growth by the year 2050 (Ohlsson, 1995a:19).

Jacobson (1988:37) introduces the concept of an 'environmental refugee', stating that this category of displaced person has become the single largest in the world, specifically where they resettle due to the pressures of reduced access to basic resources. Hudson (1996:9) refers to 'ecological refugees' which can create conflict over already scarce resources, leading to territorial disputes. This trans-boundary effect is the result of the fact that many ecosystems straddle national borders (Renner *et al.*, undated:112). State borders, except in a relatively few cases where strong state interests are combined with high administrative capacities, are mostly permeable to human migration (McNicoll, 1984:218) making this a definite regional problem. Buzan (1991:95) concurs by noting, that while international migration is controlled in theory via the enforcement of immigration regulations by a state, in practice few states can effectively seal their borders. After considerable research, Homer-Dixon *et al.*, (1996:9) conclude that environmental scarcity can contribute to population movements, economic decline and weakened states, which in turn can cause a series of socio-political problems.

It should be noted that there is a paucity of accurate population data from the Southern African states. This was discussed under the heading of "Research Design and Methodology" in the Introduction. This hampers the current research effort. The problem is that not just any population data can be used to fill in the gaps. This is because the available data has been processed by Falkenmark, Ohlsson (1995a) and Arnestrand *et al.*, (1993) into the WBS and WSI data needed for additional analysis. The population data is thus linked to other vital hydropolitical indicators, and substitute data that is at variance will impact on these indicators. As noted during the discussion on criteria for data admissibility in the Introduction, and in an effort to improve the epistemological basis of this research, the figures quoted by Falkenmark (1989:113) will be used as these are also used by SADC hydrological consultants (MacDonald *et al.*, 1990a:2.25) and SIDA (Arnestrand *et al.,* 1993:24). Where a data sequence is missing, it will be listed as (n/a) and no substitute, other than that previously deemed to be admissible, will be used. Falkenmark (1989:113) makes the population projections on all states except South Africa, which is made by Arnestrand *et al.,* (1993:21) off the same baseline figures. Unfortunately Arnestrand *et al.*, (1993) use population figures for South Africa for 1990 and 2025, whereas Falkenmark quotes figures for the other states for the years 1982, 2000 and 2025. While being somewhat of a nuisance, in the final analysis this poses no more than a minor problem, because the final grouping into WBS categories does not change materially as a result of this unfortunate situation. The important data sequence is that for the year 2025, which is fortunately intact in terms of the selected criteria for data admissibility. This minimises the potential detrimental effect that an incomplete data series would have. These form the empirical basis of this research and are presented in Table 6 that is used extensively in Chapter 3.

TABLE 6

PROJECTED POPULATION GROWTH RATE FOR SELECTED COUNTRIES IN SOUTHERN AFRICA

(Millions)

COUNTRY	SOURCE	1982	2000	2025
Angola	Falkenmark, 1989	7,43	13,23	24,47
Botswana	Falkenmark, 1989	0,86	1,87	4,06
Malawi	Falkenmark, 1989	6,57	11,7	23,19
Mozambique	Falkenmark, 1989	11,1	21,8	39,71
Namibia	Falkenmark, 1989	1,07	2,38	4,29
South Africa	Arnestrand, 1993	35,2 (1990)	n/a	63,2
Tanzania	Falkenmark, 1989	19,11	26,8	52,3
Zambia	Falkenmark, 1989	6,16	11,24	23,8
Zimbabwe	Falkenmark, 1989	7,93	15,13	32,7

These illustrate the direct link between population dynamics and water scarcity. A direct comparison can be made between three states; Botswana, Malawi and Namibia. All three have a similar volume of recoverable water resources (9 km^3 / yr^{-1}) (Table 4a and Appendix "B"). Both Botswana and Namibia have a relatively low projected level of water competition as measured on the WBS for the year 2025 (<600 people per 'flow unit'). This is equivalent to 'Mid European Conditions'. Both are extremely arid in nature, being located in an area with a low MAP and high evapotranspiration. The only reason why this is so is because the population density is relatively low, decreasing the competition level. Malawi, on the other hand, is situated in an area of higher MAP than the other two examples. The level of water competition for Malawi in 1982, as measured on the WBS, was already 730 people / 'flow unit'. This is equivalent to Position 3 'Water Stressed Conditions'. This is projected to rise to an unrecoverable position beyond the 'Water Barrier' of 2 000 people / 'flow unit' before the year 2025. This alarming fact is directly the result of the high population growth rate in Malawi, coming off an already high baseline figure.

The reader is referred to Appendix "B" for population statistics linked to Falkenmark's Water Scarcity Indicators (WSI) which are later discussed under the section on agriculture that follows.

In conclusion, it seems as if the only viable solution to the combined problem of water scarcity and population growth, is to co-operate at a regional level if the 'environment refugee' problem is to be effectively solved, as both are causally related. Buzan (1991:95) concludes that societal insecurities as the result of migration will occupy a significant position on the agenda related to national security for the foreseeable future. SADC has recently acknowledged that population pressure is probably the greatest contributing factor inhibiting sustainable socio-economic development in the region, which represents a major challenge to water resource management (De Jager, 1996:56). Arnestrand *et al.*, (1993:37) conclude that population growth is an alarming problem as it affects the amount of available water in the region on a per capita basis. Long-term solutions lie in economic empowerment of the regional population, as where this happens, fertility rates tend to drop naturally. This means industrialisation.

An Overview of Literature Related to 'Agricultural Capacity' (Third Subproblem)

It is unlikely that inhabitants of arid areas will die of thirst; they are most likely to die of starvation instead (Ohlsson, 1995a:8). One quarter of the population of Sub-Saharan Africa officially experience 'food insecurity'. This means that even under normal (non-drought) conditions, they are unable to pursue an active working life (Myers, undated:75). The per-capita agricultural production has declined by an average of 2% annually since 1970 (Myers, 1989:213). Africa is uniquely vulnerable to food insecurity due to a combination of low per capita income and rapid population growth, which has resulted in the continent sliding from a position of food self-sufficiency over the last three decades, to a current dependence for one fifth of its food from outsiders (Ohlsson, 1995a:6). This is linked in part to the fact that not only do the arid areas of Africa receive a low total MAP, but two thirds of the region receive their annual rainfall in just three months. This limits the growing season, and it means that as much as 44% of the region already experiences drought as a major limitation to rainfed agriculture (Myers, 1989:216). Both Falkenmark, (1989:114) and MacDonald *et al.*, (1990a:2.25) note that Gustafsson has determined that a country would have the capacity to be self-sufficient in food production at the subsistence level based on rainfed agriculture if there is a minimum of 1 250 m^3 / p / yr^{-1}. This translates to 800 people / 'flow unit' on the WBS (Refer to Appendix "C" for the conversion). Of significance however, this figure does not make any allowance for water availability for either industrial or irrigation demands (Evans, 1995:2.8).

After studying the most successful traditional cultivation systems that history had recorded - those of eastern Asia, the Nile River basin and the Netherlands - Vaclav Smil concluded that a threshold level of 0,07 hectares of arable land per person was incapable of feeding their population on a sustainable basis without intensive use of synthetic nitrogen, phosphorous and other technological improvements. This threshold signals the transition to the vulnerability of dependence on extensive modern inputs. The crossing of this threshold is seen as a permanent event without subsequent expansions in land availability or considerable decrease in population size.

This is significant within the context of 'virtual water', as when this condition is encountered, the state with a subsistence-based economy, is usually rendered impotent in dealing with their own internal crises that arise as a result. The transition to an industrialised economic base is severely hampered and the degraded environment implies that food imports, which now become a necessity, cannot be paid for. Such a state inevitably enters into a debt trap from which escape is difficult. Under these conditions, it is doubtful whether 'virtual water' would have any benefit. In terms of this, it is significant that both Malawi and Tanzania will reach this threshold by the year 2025, followed by Lesotho, Mozambique and Swaziland by the year 2050 (Ohlsson, 1995a:33-4). This will be discussed in more detail in Chapter 3.

Concerning food production statistics, it is noted (Ohlsson, 1995a:7) that they tell us more of the economic conditions than potential food production capacity, as food not grown can be purchased on the open market if the economy is strong enough.

In an attempt to answer the "so what" type of question that these statistics raise, Falkenmark (1989:116) introduces a useful concept in the form of the WSI. This relates 'water competition' in a given country, as derived from the WBS, to the varying levels of technology needed to compensate while maintaining self-sufficiency. The implications of this, in the context of the current research, are that states with a combination of a major population growth problem and lack of economic development, are less likely to be able to afford the progressively higher levels of technology needed to maintain self-sufficiency. Population growth on its own is therefore not the problem. The true nature of the problem lies in developing the capacity to deal with the consequences of the increased population. This is the true value of the WSI concept. For ease of reference, a condensed version of the WSI (Arnestrand *et al.*, 1993:24) is presented as Table 7.

TABLE 7

CONDENSED 'WSI' FIGURES FOR SELECTED SOUTHERN AFRICAN STATES

COUNTRY	AVERAGE ANNUAL POPULATION CHANGE (%)	PROJECTED POP. 2025 (MILLIONS)	**WSI** 1982	**WSI** 2025
Angola	2,7	24,5	11	12
Botswana	3,51	4,06	11	22
Malawi	3,31	23,2	13	25
Mozambique	2,65	39,7	12	23
Namibia	3,3	4,29	22	32
South Africa	2,19	63,2	33 (1990)	44
Tanzania	3,67	52,3	12	24
Zambia	3,76	23,8	11	12
Zimbabwe	3,15	32,7	12	24

To appreciate the relevance of the problem regarding access to technology, Gleick (1993:91) indicates that in Africa as a whole, only 6% of cropland is irrigated (compared to 16% world-wide). Within the context of a 'virtual water' discourse, one of the pivotal notions is that regarding the SWE and the allocation of scarce water to the economic sector where it enjoys the best return. Firstly, irrigation is needed in modern societies, as this method of crop production is more efficient than normal rainfed agriculture. This also implies that increasing levels of technology are needed, as typically the better suited land is used first with additional demand for agricultural products forcing farmers to begin farming increasingly more marginal land. For example, primitive irrigation systems involve an open canal leading water to a field utilising the energy provided by gravity. More advanced systems involve pressurised pipelines using electricity or fossil fuel as an energy source. Thus irrigation on its own represents a relatively high level of technology, which large parts of Africa simply do not have. Secondly, irrigation within an arid environment becomes problematic for at least two reasons that are relevant to this discussion. One the one hand, by definition such environments have an exceptionally high evapotranspiration rate. Therefore, most of the water is simply lost to the atmosphere and returned to the hydrological cycle, without any benefit to the crop being produced. In order to prevent this loss, progressively more sophisticated methods of irrigation need to be used. These include the use of plastic mulches, drip systems, hydroponics, NFT (nutrient film technique) technologies, etc. Each method is more technologically advanced than the previous and therefore more costly. On the other hand, irrigation consumes large quantities of a states' water budget. This is significant in an arid climate where water is already scarce. Thus the advantages of a 'virtual water' rationale is that irrigation is only feasible in arid climates where the crop produced is a high value one that justifies the actual cost of the original water. In all probability, better use could be found for the water in an arid climate in terms of the 'virtual water' concept.

The most important aspect of the 'virtual water' discourse to note at this stage, is that improved water management will only make a difference when it is accompanied by intensive economic development, preferably in the manufacturing and industrial sectors. This aspect is discussed in greater detail in subsequent chapters. Therefore irrigation on its own is simply not a viable solution for a developing country in an arid region. A 'virtual water' based development strategy implies agricultural imports, which in turn needs a healthy balance of payment situation, with sufficient foreign reserves, in order to be sustainable.

Nearly 20 countries in Africa have no irrigation supply technology at all. Gleick concludes that the access to capital, technology and know-how are the major pitfalls. Within the Zambezi Basin, 92% of the arable land is not yet cultivated (Arnestrand *et al.*, 1993:10). Thus for Botswana to improve from a WSI level of 11 in 1982, to a WSI level of 22 in 2025, is probably attainable. This is indicated by the lower value of the first WSI digit, which means that lower levels of technology will be required. By contrast, it will be relatively more difficult for Namibia to increase from a WSI level of 22 in 1982, to a WSI level of 32 in 2025, as the higher value of the first WSI digit implies high levels of technology will be needed (Appendix "B" and Table 7). This implies that a state like Namibia will find it increasingly difficult to achieve self-sufficiency. This concept is discussed in much more detail in Chapter 3, where it is applied to each individual state.

Related to this is the issue of land degradation caused by desiccation. Some 20% of Southern Africa, covering Namibia, Botswana and South Africa, is severely affected (Arnestrand *et al.*, 1993:20). This problem is exacerbated by the fact that in an agrarian society, as the population grows, the land becomes even more subdivided. Population growth intensifies the struggle for land, which is the most valued commodity in such societies. Rural competition increases and income levels fall unless the urban and industrial sectors are growing, and thus drawing off the surplus labour from the agricultural sector (Leroy, 1986:169). This is a key factor in the research, as 'virtual water' can only become a potential solution if the industrial sector is viable and growing.

The overall problem as already sketched above is complicated further by the desires of most of the developing countries to become self-sufficient in food staples (Falkenmark, 1986:109). This is also relevant to the 'virtual water' concept as it implies that self-sufficiency must be foregone as a sacrifice for a more rational use of water, based on industrially driven economic growth. Significantly, Botswana has already made this paradigm shift and has adopted a policy of 'food security', based on the advantage of a strongly diversified economy, rather than 'food self-sufficiency' (Arnestrand *et al.*, 1993:31). South Africa is fast approaching the point where a major policy decision concerning this has to be made. In this regard Conley (1996c:19) notes that South Africa has reached the point where scarce water resources need to be divided in such a way that water allocation is based on economic returns. This is in keeping with the transition from a "common" to a "precautionary" developmental trajectory as theorised by Karshenas and incorporated into the concept of 'virtual water' as discussed in the previous chapter.

On closer analysis an absurd situation is revealed. In water scarce countries, one of the largest users of water is the agricultural sector (Allan, 1996c:85; 1992:377; Davies *et al.*, 1993:194), yet it typically makes the smallest contribution to the GNP (Allan, 1996b) of such economies. In fact, as Allan (1996b) bluntly stated, "Israel changed their water policy in 1986 when they realised that they were exporting their scarce water in the form of cheap oranges grown on some kibbutz in the desert to water-rich Europe". De Jager (1996:41) is of the opinion that while water consumption in the agricultural sector tends to account for between 65% to 90% of water use in a national economy, water allocated to the industrial sector is remarkably productive. A concept which helps to evaluate the comparative significance of differing land and water resource using systems, is that of 'returns to water', or the 'productive efficiency of water', but that provision of water to these sectors in a competitive system is a sensitive political matter (De Jager, 1996:42). These concepts are recognised in the White Paper on Water Policy for South Africa (DWAF, 1997:2.2.1). Since agriculture claims the bulk of most nations' water budgets, saving even a small fraction of this frees a relatively larger amount to meet other needs (Postel, 1984:39). In this regard there is a kind of "leverage" or "gearing" effect. The concept of 'returns to water' will be extensively used in Chapter 3. There the problem is quantified on an individual basis within each state by using available hydrologically derived data.

Heyns, of the Namibian Department of Water Affairs, has calculated current and projected water demand for agriculture in the Southern African region based on hydrologically acceptable parameters. Table 8 (Ohlsson, 1995a:44) is a partial rendition of this, and shows the two countries whose demand surpasses the total available. Significantly these are the two countries that have already, or are considering, a fundamental policy shift away from the national self-sufficiency paradigm, Botswana and South Africa.

TABLE 8
STATES WHOSE CURRENT AND PROJECTED WATER DEMAND EXCEEDS AVAILABLE SUPPLIES
(km^3 / yr^{-1})

COUNTRY	1993 DEMAND	1993 IRRIG	2020 DEMAND	2020 IRRIG	AVALIABLE
Botswana	0,129	0,020	**0,336**	0,047	**0,230**
South Africa	19,295	9,615	**30,168**	12,674	**28,470**
TOTAL	19,425	9,635	**30,504**	12,721	**28,700**

The data used in Table 8 is derived from the calculation of a percentage of the Absolute Total (Ohlsson, 1995a:44). This is the amount that hydrologists assume to be available because it has not yet been fully committed. The data, which is represented in Appendix "B", is the data that forms the empirical basis of the study. Tables derived from other sources are used merely to illustrate specific points such as this.

Evidence exists that the allocation of water, according to principles of 'returns to water', would shift water from non-viable economic activities, such as marginal agriculture, to more economical uses (Allan, 1992:382). This is clearly needed for the states listed in Table 8 if their water budgets are to be balanced. In the case of South Africa, the White Paper on Water Policy recognises this (DWAF, 1997:2.2.1). It is noted (Allan, 1992:380) that the primacy of the political context in the development and allocation of economically and ecologically sustainable policies is recognised. Only through effective political institutions will leaders have the confidence to direct water resource allocation strategies at home, and to reach acceptable international agreements abroad. By doing this, the concept of the 'virtual water' content of a commodity or service can be used regionally to move water, usually via trade, but without the encumbering volume of actual water needed to produce the service or commodity in the first place (Allan, 1996a). This needs a definite development strategy to work however. Once a country has developed a sufficiently strong, diversified economy, it can leverage its own scarce water supplies to pay for imports of water-intensive commodities, by allocating its own water to uses which yield higher financial returns (Conley, 1996a:20). The global economy has been favourable to water deficient political-economies in the past, however this is changing with the aims of the World Trade Organisation (WTO) now being to minimise subsidies for agricultural products. This implies that in the future cereal prices are likely to increase. Already the international price of wheat rose in 1995 from US$100.00 / tonne to US$160.00 / tonne (De Jager, 1996:45).

Unfortunately no accurate data exists linking actual agricultural outputs of the SADC Member States to water consumption per sector. SADC have also reported to UNCED that current data is insufficient (Ohlsson, 1995a:22) for a range of analytical purposes. Bannink (1996:15) provides some useful data however, which shows the agricultural sectoral use expressed as a percentage of all water use in Zambezi Basin states. This is presented as Table 9 overleaf. Unfortunately industrial water consumption is not included in this data set. This data reveals that agriculture accounts for more than 75% of the total water consumption in Angola, Botswana, Namibia and Zimbabwe, and between 50% and 75% in Mozambique, and Tanzania. Malawi has less than 50% with Zambia being in a favourable position at 26%. Significantly these findings are in keeping with the view expressed by Allan quoted above.

TABLE 9

WATER DEMAND OF ZAMBEZI BASIN STATES BY ECONOMIC SECTOR

	UNIT	YR	AN	BOT	MAL	MOZ	NM	TAN	ZA	ZIM
Use	m^3 / p / yr^{-1}	'87	57	100	20	55	104	35	86	136
Agric. use	**as %**	**'87**	**76**	**85**	**49**	**66**	**82**	**74**	**26**	**79**
Derived water use	$10^6 m^3$ / yr^{-1}	(*)	564	130	206	831	156	977	740	1442
Derived agric. use	$10^6 m^3$ / yr^{-1}	(*)	429	111	101	548	128	723	192	1139
Water demand	$10^6 m^3$ / yr^{-1}	'93	1135	129	1135	1976	265	5374	994	2524
Irrigation	$10^6 m^3$ / yr^{-1}	'93	350	20	795	1308	108	4560	690	2175
Irrigation water / ha	$10^3 m^3$ / ha / yr^{-1}		16	20	15	12	22	12	15	15

(*) uses 1992 population figures in conjunction with 1987 water use rates.

Fortunately slightly better data does exist for South Africa (Davies *et al.*, 1993:3). This is presented in Table 10 overleaf. Surprisingly, prior to the democratisation of South Africa, there was little concern among planners regarding the sectoral allocation of water in South Africa. This was possibly due to the fact that a strong portion of the constituency of the ruling party were farmers, so there was little political advantage to reveal the full extent of their water consumption, and possible inefficiency. There are still sensitivities regarding this aspect which became evident during direct interviews that the author had with various officials. Accordingly, such data is scarce. The best data available is presented in Table 10. This can be used to illustrate the point relevant to the application of Allan's concept of 'virtual water', as it shows a decrease in agricultural consumption over time. This probably conforms to the Karshenas model but unfortunately the data sequence is too short to show this conclusively. A general trend is evident however. The figures for agriculture show a steady decline in South Africa, while those of both the industrial and domestic sector show a slow but steady increase. This can tentatively be interpreted as conforming with the data for Israel upon which Allan based his original model (Allan, 1996c:83). This is a necessary pre-condition for the benefits of 'virtual water' to be realised.

TABLE 10

SECTORAL WATER DEMAND FOR THE SOUTH AFRICAN ECONOMY
Projected to the Year 2010

Volumes expressed as 'flow units' of one million m^3 / yr^{-1}

	1980		1990		2000		2010	
SECTOR	VOL.	%	VOL.	%	VOL.	%	VOL.	%
Industry	1 031	6,3	1 448	7,6	2 043	9,1	2 961	11,4
Mining	466	2,9	511	2,7	582	2,6	649	2,5
ESCOM	282	1,7	444	2,3	779	3,5	900	3,5
TOT INDUST.	**1 779**	**10,9**	**2 403**	**12,6**	**3 404**	**15,2**	**4 510**	**17,4**
Irrigation	8 504	52,2	9 695	50,9	10 974	48,9	11 885	45,9
Stock watering	262	1,6	288	1,5	316	1,4	358	1,4
TOT AGRIC.	**8 766**	**53,8**	**9 983**	**52,4**	**11 290**	**50,3**	**12 243**	**47,3**
DOMESTIC	1 516	9,3	2 281	12,0	3 220	14,4	4 477	17,3
Other	4 230	26,0	4 376	23,0	3 524	20,1	3 658	18
TOTAL	**16 291**	**100**	**19 043**	**100**	**21 438**	**100**	**24 888**	**100**

The data in Table 9 does indicate a high sectoral water consumption for agriculture in the rest of the region, but unfortunately the data set does not allow for analysis over time. This will be further investigated in Chapter 3, where sectoral contribution of each Zambezi riparian state and South Africa will be analysed in greater detail.

Statistics are available that show the relative magnitude of the production of selected agricultural commodities from SADC Member States from 1967-87 (SADC, undated:5/32). These are presented in Table 11 overleaf. This table indicates the heavy production of South Africa compared to the rest of the region. The alarming situation in Mozambique is evident with low production levels relative to size and actual potential. This drop in production is explained partly in terms of the civil war, especially from 1980 to 1987. In the next chapter, the performance of each state will be discussed in greater detail. As De Jager (1996:53) notes, it is recommended that Southern African states should co-ordinate their policies on grain acquisition. While this will improve security of access to 'virtual water' through grain purchases on the global market, "currently short-term political logic prevails over a more durable economic approach to the use of scarce environmental resources" within the region.

TABLE 11

PRODUCTION OF MAJOR FOOD CROPS BY SELECTED COUNTRY
1965-87 ('Million Tonnes)

	YEAR	MAL	MOZ	TAN	ZAM	ZIM	RSA
Maize	1965	890	390	751	800	822	4 608
	1980	1 165	380	1 726	937	1 511	10 900
	1987	1 228	300	2 337	954	1 094	7 350
Sorghum	1965	55	181	149	44	52	1 040
	1980	120	200	563	20	42	1 908
	1987	154	150	663	26	52	1 725
Wheat	1965	1	10	33	0	4	656
	1980	1	3	91	10	191	1 472
	1987	1	3	72	13	200	3 146
G'nuts	1965	157	120	49	44	61	611
	1980	177	90	54	16	78	707
	1987	190	65	60	14	79	538

Should this envisaged co-operation lead to a series of international agreements being reached between Southern African states, foreign currency can be generated by harnessing the greater potential yield that industry offers as a 'return to water' than agriculture does. As already indicated, Botswana has made this policy shift (Ohlsson, 1995a:12), with South Africa rapidly approaching this point (Conley, 1996c:19). This is discussed in detail in the next chapter. Significantly however, it is noted that future food security within Southern Africa is dependent on the exploitation of the water resources of the Zambezi River basin (Arnestrand *et al.*, 1993:14). This suggests an increased competition that is likely to become apparent between riparian states. The reader is referred to the following discussion under 'industrial development' that illustrates this further.

An Overview of Literature Related to 'Industrial Development' (Fourth Subproblem)

Economic growth in Southern Africa as a whole is amongst the lowest in the world, actually declining during the 1980s in more than half of the countries of the region, with GDP growing in general at a slower pace than population growth (Ohlsson, 1995a:22). Underdevelopment, coupled with water insecurity, is seen as a recipe for conflict (Hudson, 1996:9). As already noted (Myers, undated:27), a combination of environmental degradation and growing populations can trigger mass migrations. These refugees can target the sanctuary of more developed countries, or they can migrate to informal settlements around the major industrialised towns and cities. This migration of people to areas of perceived wealth is already taking place in the Southern African region, with the main target area being Gauteng and other industrialised centres in South Africa. It is the industrial heartland of the region, the Pretoria-Witwatersrand-Vereeniging (PWV) triangle of the Gauteng Province, which produces some 50% of the GDP of South Africa (Arnestrand *et al.*, 1993:29) that attracts impoverished migrants. Urbanisation figures for Zambezi Riparian States are given in Table 12 which show this trend (SADC, undated:11/14).

TABLE 12

URBANISATION OF ZAMBEZI RIPARIAN STATES

	URBAN POPULATION			
	AS % OF TOTAL POP		AVG. ANNUAL GROWTH (%)	
	1965	1990	1965-80	1980-90
Angola	13	28	6,4	5,8
Botswana	4	28	12,6	9,9
Malawi	5	12	7,4	6,2
Mozambique	5	27	10,2	10,4
Namibia	17	28	4,6	5,3
South Africa	47	60	3,2	3,7
Tanzania	5	33	11,3	10,5
Zambia	23	50	6,6	6,2
Zimbabwe	14	28	6,0	5,9

By referring to the first two columns, it is evident that strong urbanisation trends are present in almost all states, with dramatic figures emerging from Botswana, Mozambique, South Africa and Tanzania. Accurate statistics were not available for illegal immigration to South Africa at the time of doing this research, but it is considered to be exceptionally high. Conley (1996c:58) notes that while South Africa contains about 30% of all of the SADC population, it has a GNP about 4,5 times that of all of the SADC Member States combined. He concludes that if the South African economy steadily strengthens, while the rest of the region stagnates, then migration to South Africa will continue (Conley, 1996c:59). It is the contention of the author that it is the spatial inequality of industrial development within the region that exacerbates this problem.

Other sources of data indicate a similar trend. An example of data indicating sectoral employment in selected countries of the Southern African region is presented in Table 13, which also shows the migration trends (Esterhuysen, 1992:83). (Namibia is missing, as pre-independence data has unfortunately not been recorded separately).

TABLE 13

SECTORAL EMPLOYMENT IN SELECTED SADC STATES
Sectoral distribution of labour force
showing percentage of economically active persons in each sector

	Agriculture		Industry		Services	
COUNTRY	**1965 %**	**1985-88 %**	**1965 %**	**1985-88 %**	**1965 %**	**1985-88 %**
Angola	79	74	8	10	13	17
Botswana	89	70	4	13	8	17
Malawi	92	82	3	3	5	15
Mozambique	87	85	6	7	7	8
South Africa	32	14	30	24	39	62
Tanzania	92	86	3	4	6	10
Zambia	79	38	8	8	13	55
Zimbabwe	79	65	8	5	13	30

This table shows a tendency for a more developed country like South Africa to absorb people into the services sector, away from agriculture. The effects of the economic impact of the liberation struggle in the 1970s and 1980s probably accounted for the negative trend in the South African industrial sector. This can also indicate increased efficiencies due to the application of technology in preference to labour, when compared to the data in Table 14, which shows a moderate growth for the South African industrial sector in dollar terms for the same period. It also shows that a country like Botswana is still heavily dependent on agriculture, but with a growing industrial and services sector. The effects of the protracted war in Mozambique and Angola can be seen, with hardly any growth of the industrial or services sector evident in those countries. These facts are noted in general terms only in order to illustrate a point. Each state will be analysed in greater detail in the next chapter.

Gleick (1993:90) suggests that some countries could eventually reach an absolute limit on both the type and extent of industrial development due solely to constraints on the availability of fresh water. This depends on three factors:

- absolute availability of water

- population needing to be provided for
- level of development required

As Falkenmark (1989:113-118) notes, there are few models to follow for socio-economic development under severe water scarcity conditions. She concludes that;

> "a general national water strategy for socio-economic development has to be formulated, based on the water availability constraints and permitting in addition to household supply, *only low-water use agriculture and industry*" (emphasis added); and that "industrial development is severely threatened unless new techniques can be developed which are not based on water as available in the temperate zone".

Returning to Allan (1992:377), where he attempts to quantify the 'return to water' from agriculture in a semi-arid region. While acknowledging that the volume of water used / hectare of production will obviously differ from place to place, he generalises by stating that for irrigation purposes, under semi-arid conditions, for two seasons / year (given the longer summer periods compared to a temperate region), takes as much as 15 000 m^3 / hectare. The yield of this irrigated crop is in the region of US$4 000 / year. This is a low 'return to water' compared to the USA that takes 1 000 m^3 / hectare to generate a yield of US$23 000 / year. Allan *et al.*, (1996d:130) thus conclude that,

> "in economies in which agriculture is dominant, returns to water will be modest, (whereas) in an industrialised economy, returns to water will be high and livelihoods more numerous ... emphasising the need to introduce economic principles and instruments into water policy, albeit at a rate which is consistent with the political acceptability of the approach".

Conley (1996b) notes that the regional industrial heartland, Gauteng, is in an area with the relatively lower share of the MAP, indicating the developmental unevenness when compared to water supply. Davies *et al.*, (1993:142-3) refer to the "mismatch between water availability and historic population development" centred on Gauteng, where water naturally flows away from this area due to its location on the watershed, necessitating a large number of IBTs to keep the supply secure. An alarming statistic that illustrates this is the fact that after the LHWP is in operation, >75% of the flow of the Vaal River, the main water supply for Gauteng, will be imported from other basins.

At this time, a broad data set to show the contribution of each sector to the total GDP of selected Southern African states, is introduced as it illustrates a general point. This is presented in Table 14 (Esterhuysen, 1992:82). In Chapter 3 more refined data will be used for each Zambezi riparian state and South Africa.

TABLE 14

ECONOMIC SECTORS OF SELECTED SADC STATES
Indicating sectoral distribution of GDP from 1960 - 1989
Expressed in US$ Terms

	Total GDP US$		Agriculture		Industry		Services	
COUNTRY	**1960**	**1989**	**1960**	**1989**	**1960**	**1989**	**1960**	**1989**
Botswana	50	2 500	34	3	19	57	47	40
Malawi	160	1 410	50	35	10	19	40	45
Namibia	197	1 650	16	11	44	38	40	50
South Africa	6 980	88 870	12	6	40	44	48	50
Tanzania	550	2 540	57	66	11	7	32	27
Zambia	680	4 700	11	13	63	47	26	40
Zimbabwe	780	5 250	18	13	35	39	47	49

Analysis of Table 14, in conjunction with Table 9, shows that certain countries such as Tanzania experienced an increase in the contribution from agriculture, with a decrease in the contribution from industry, suggesting inefficient use of their water resources. Zambia shows an agricultural increase, but with a very low sectoral water use, suggesting that this country has significant potential for future agricultural development, if the Southern African states adopt a joint policy of regional food security rather than national self-sufficiency. Both Namibia and Botswana, as examples of the most arid states in the region, decreased their contribution from agriculture, but show excessive agricultural sectoral water consumption (>80%). Botswana increased its contribution from industry suggesting the start of a better sectoral use of water, (which is in keeping with its new strategy of 'food security' as already noted above) while Namibia showed a decrease in the industrial contribution, suggesting that their water efficiency is probably lagging behind. These interpretations are tentative at this stage, but after discussions with Allan (1996b) are felt to be linked to water allocation and availability. This will be examined more closely in Chapter 3.

South Africa shows the kind of tendency that would be expected in terms of the Karshenas model used by Allan, with a decline in the contribution from agriculture, coupled to a general increase from both the industry and services sector. This again suggests that South Africa is approaching the point that Israel passed in 1986 (Allan, 1996e), where alternative water allocation policy options can be implemented, resulting in a changed developmental trajectory. The trend evident in Table 10 is suggestive of this. If this conclusion is valid, then the agricultural sectoral water consumption curve for South Africa would be expected to begin a more rapid decline in future, with only a small but steady increase in the industrial and domestic consumption of water, much like that evident in Figure 3 on page 35. This also indicates the pitfalls in drawing concrete conclusions from incomplete data sets. Attention is drawn to Table 13, which suggests a decline in industrial labour employment terms for South Africa. Both data sets combined suggest a marginal increase in efficiency, probably due to applications of technology, as the total value of the industrial sector grew moderately (Table 14), while employing fewer labourers.

This data, when compared to a general table of present and projected sectoral water demands for Zambezi riparian states (Bannink, 1996:29), illustrates the point being made regarding agricultural sector inefficiency. This is presented in Table 15, which shows a dramatic combined projected increase for agriculture compared to industry over time, with industry clearly using substantially less water than agriculture.

TABLE 15

PRESENT AND PROJECTED SECTORAL WATER DEMANDS
Combined for Zambezi Riparian States

WATER DEMANDS	UNIT	1990	2040
Irrigation water	$10^6 m^3 / yr^{-1}$	8 300	65 000
Industrial water	$10^6 m^3 / yr^{-1}$	330	1 700

There is a tendency at an early stage of development to over-use and degrade renewable resources such as water. This is indicated in the Karshenas model discussed in Chapter 1. At a later stage of development, possibly influenced by the need for an environmentally sensitive agenda, a stronger and more diverse political economy can contemplate the re-allocation of resources previously abused. In this context however, it is important for the policy-makers to note that water management takes place in "open political-economies and not in closed hydrological and engineered systems". Politicians prefer to make policy in such closed systems, as they are more convenient than international wrangling with unyielding riparian neighbours. Policy-makers in arid economies can seek remedies in the wider global economy, rather than in the smaller, unnaturally defined hydrological system, based on segments of a drainage basin that constrains them. Trade provides the remedy by allowing the option of moving highly subsidised 'virtual water' from elsewhere in the global economy (Allan, 1996e).

It is therefore enlightening to know that a significant industrial re-location is currently being planned for Beira and Maputo in Mozambique (Maduna, 1996), in line with the fourth hypothesis of this research. ALUSAF, a major aluminium producer, has successfully negotiated a deal whereby the price of electricity is linked to the aluminium price as quoted on the London Metals Exchange. Electricity is one of the major cost components in the production of aluminium, and Beira is conveniently located with respect to both the Cahora Bassa Dam and a large labour pool. The power of the waters of the Zambezi River Basin will thus be harnessed in keeping with the logic of this research, for the mutual benefit of all. The question is whether this type of decentralisation is sufficient in the face of the overall magnitude of the problem?

To this end it is also significant to note that Malawi's, Zambia's and Zimbabwe's current industrial centres are situated within the Zambezi drainage basin, but that their current industrial sectoral water use is generally low at present (Conley, 1996c:40). This means that the advantages of 'virtual water' can be uniquely beneficial to this part of Southern Africa. The suggestion that industry can become a substantial driving force, in the face of population and agricultural capacity pressures inherent within the region (Bannink, 1996:31), thus appears to be tentatively valid at this stage.

It is also encouraging to note that the White Paper on Water Policy for South Africa (DWAF, 1997:6.6.2) states:

> "Where water is needed to produce water-intensive products such as food, wood and electric power, it may be a more efficient use of resources to import them, rather than attempt to produce them in a water-stressed area. *This use of trade between countries and regions as a measure to achieve the best use of water has not been properly studied in Southern Africa*". (Emphasis added).

This indicates that the regional hegemon has embraced the essence of 'virtual water', and is prepared to use this to foster regional integration within SADC (DWAF, 1997:2.2.4).

An apt comment made by Prof. J.A. Allan illustrates the sectoral water efficiency dilemma (Conley, 1996c:61):

> "If policy-makers have the awareness, freedom and capacity to address the full range of factors affecting water allocation and management, they will prevent the all too common situation where resource users are doing the wrong thing efficiently, which is usually worse than doing the right thing a little badly".

Conclusion

A point must be clearly made at this juncture. The comparative nature of the data used in this chapter illustrates a general trend only. It also shows some of the pitfalls from using too narrow a set of data. The reason why these tables are presented in this chapter is to illustrate a point in terms of a general discussion of a sub-problem only. This also supports the choice of the more in-depth approach that is used in the next chapter. In Chapter 3 each state is analysed on an individual basis in far more detail than has been the case thus far. All that has been identified up to now are superficial, general trends only.

Another manifestation of the basic dilemma presented by this research must also be highlighted at this stage, as it will become evident as the reader continues beyond this point. The dilemma revolves around the type of approach best suited to the subject matter. On the one hand, the rationale of 'virtual water' implies a regional approach, whereas on the other hand, each state seems to be pursuing their own objectives independently of each other. The former implies a dynamic of supra-nationalism whereas the latter implies one of state-centrism. The view of the author is that the problems identified in this chapter are of such an inter-linked nature, that their effective solution lies beyond the capacity of any one state to resolve. In other words, a regionalistic view is being expounded. The problem is that the international regional organisations are not yet fully geared to cope with the demands that this will place on them. This is exacerbated by the fact that each state within the configuration under review tends to still view themselves in individualistic terms. This ties in with the Realist / Idealist dilemma originally noted on page 23.

Given the fact that this study has sought to provide an alternative view of the problem, it is felt that at this stage of the research, it is too premature to start grouping states together. The reason for this is that the hydropolitical dynamics, which have their roots in each state, are not yet known. It is therefore necessary to first apply the selected hydropolitical methodology to an analysis of each individual state, in order to enable states that subsequently present with similar sets of hydropolitical conditions, to be grouped together. Therefore, what has been presented up to this point, are general trends only. It helps little to pursue an approach based on the logic of a regional solution, when the regional structures are not yet fully formed, and where formed, are inadequately funded and therefore lacking in capacity. By the same token it helps little to do a comparative analysis of the water policy of each state, as these are too fragmented. In many cases they fail to address the population dynamic in any form. This is a significant dilemma, but the line of attack that has been selected by the author is felt to be the most prudent under the circumstances. In the final analysis, the individual state approach is felt to be the most productive route to follow, until the point is reached where states that display similar hydropolitical dynamics have been identified and can then be linked into groupings.

The conclusion that efficient and effective management of the shared watercourse systems of the Southern African region, holds a critical key to the resolution of the current economic problems (De Jager, 1996:50), is therefore considered to be valid. This SADC Water Protocol devolves the responsibility for co-operation down to each individual state. This again raises the dilemma noted above. Should this be studied from a regional perspective or from an individual state perspective? On balance, an individual state approach seems to be justified under these circumstances.

There also appears, at face value, to be evidence of the type of profile presented by Karshenas and used by Allan as the theoretical basis of his concept of 'virtual water' in the case of certain states. This is extremely tentative at present, and needs a more detailed analysis. This will be done in the next chapter.

Regarding the first subproblem, it can be seen that the region is facing an increased water scarcity in the future. The main cause of this is the growth in the population that will be forced to compete for the finite resource. Global warming and other climatic factors have been suggested by certain authors. This is beyond the scope of the current research. What can be said however, is that while climate change *may* be a factor, the impact of growing human populations certainly is. It is therefore concluded that there is indeed a water scarcity problem being felt in the study area, which is largely due to the fact that more mouths need to drink a finite amount of water as populations grow. This is taken to be a proven fact from this point on in this research and will not be discussed further. In other words, the first subproblem is considered to be validated. There is indeed a water scarcity facing the region. The original point of departure, as expounded in the methodology, was to accept that the predictions made by Falkenmark are in fact valid, and concentrate rather on the ramifications of this state of affairs.

Co-operative solutions are advocated by a number of researchers. 'Virtual water' as a potential solution can function best if a degree of co-operation exists, in order to harmonise policy in a region that is facing a water shortage. What then is the likelihood of this functional co-operation to occur in the Zambezi Basin and South Africa? A Water Protocol exists, but the international regional organisations that are needed are poorly developed and inadequately funded at present. This Protocol calls on each state to initiate co-operation and thus provides little leadership in this regard. Here we again have a manifestation of the underlying dilemma. Regionalism versus State Centrism! Idealism versus Realism!

Regarding the second subproblem, the evidence presented seems to establish the fact that the increased water scarcity in the region is causally linked to population growth. Given the history of the problems related to human migration that Africa has experienced, coupled to the generally low level of state administrative capacity, any given state is unlikely to be able to protect itself in the event of an influx of migrants that may result from high water competition levels elsewhere. Again solutions of a functionally co-operative nature seem to be appropriate. Yet again the structures needed to achieve this seem to be inadequate when weighed against the magnitude of the task or the complexity of the problem. The sobering conclusion is that, given the exponential rate of population growth evident, severe strain will be placed on the available water resources, even if a successful population control policy succeeds in reducing fertility rates. There is thus a causal link to the first subproblem. Population growth is a major component of the projected water scarcity. This subproblem is thus also considered to have been validated and will not be discussed further. Epistemologically, this proof is derived from the research design, as the criteria for data selection is based on Falkenmark's WBS and WSI as hydropolitical indictors. These indicators, by definition, measure the impact of population growth on available water supplies. Veracity is thus determined in this case by original definition. This enables the research endeavour to move on to examine the implications of this problem.

Regarding the third subproblem, it can be seen that a combination of low per capita income and rapid population growth, has resulted in food insecurity problems in the study area. Food importation can best be financed by means of a strong and diversified economy if sustainability is to be a policy objective. The problem in arid regions is that the agricultural sector typically uses a high proportion of the total water consumed, so the desire for agricultural self-sufficiency actually exacerbates the water scarcity problems. It could even be argued that without excessive agricultural demand for water, which in turn generally contributes only a small percentage of the total GDP while being a heavy consumer of water, the region is not actually facing a water scarcity problem in the first place! Yet again the proposed solution is a functionally co-operative type of arrangement in that food imports are best managed if co-ordinated on a regional basis. Population migration can be stimulated, at least in part, by push-factors such as drought induced crop failures in states with a subsistence based economy. There is thus a direct link between the third and second subproblems. Growing populations need to be fed, so they place pressure on the agricultural sector. This sector in turn, in order to meet the growing demand to feed the expanding population, expands the irrigation base, thus tying up scarce water in an activity that has a known low rate of return. The problem can thus be seen as a spiral.

Regarding the fourth subproblem, it can be seen that economically uneven development in spatial terms can result in population migration by providing pull-stimuli. There is thus a link to the second subproblem. There is also a link between the third and fourth subproblems, as both sectors compete for scarce water resources in arid regions. The latter is recognised in the White Paper on Water Policy for South Africa. Because people need to eat in order to survive, the water is allocated rather to human consumption and agricultural use, with industrial demands being left low down on the list of allocation priorities. Food riots are not a prospect that politicians in developing states relish! The question that now needs to be answered is whether the proposed industrial decentralisation is adequate enough to counter the migration trend, and whether the industrially driven economic growth will be of an order of magnitude sufficient enough to allow 'virtual water' to become the solution?

There is a link between the four subproblems presented. The suggestion at this stage is that the four subproblems can be seen as a spiral. Water scarcity (first subproblem) is largely population induced (second subproblem), although climate change may also play a role. This in turn places demands on the agricultural sector (third subproblem) to feed the growing masses. In an agrarian economy, the emphasis is on subsistence with a weak industrial base typically being the case. This impacts on the environment, with ever more marginal lands being used for crops, and increasing demands being made on water supplies. The issue of technological availability now comes into play (Falkenmark's WSI) and issues such as critical thresholds like land availability per capita (Vaclav Smil) become relevant. Then comes the issue of industrial development (fourth subproblem). Where industry exists, it provides a pull-factor for migrants (second subproblem). Industry (fourth subproblem) now competes with agriculture (third subproblem) for water allocation. This is recognised in the White Paper on Water Policy for South Africa. A 'virtual water' based development approach needs a strong industrial base however, in order to take advantage of the gearing inherent in the better SWE that the industrial sector provides. The industrial sector (fourth subproblem) has the responsibility of generating sufficient hard currency, in order to purchase 'virtual water' on the international cereal market, so as to balance the water budget of the arid state and thus alleviate the pressures being placed on the agricultural sector (third subproblem).

It now becomes necessary to examine each individual state in detail, in order to determine the exact hydropolitical dynamics that originate in each so that groupings can be considered between states that have similar hydropolitical profiles.

CHAPTER 3

QUANTIFICATION OF THE PROBLEM

Introduction

In the previous chapter, the four subproblems were discussed, and cursory mention was made of certain states in order to illustrate a general point. In this current chapter the problem will be quantified in depth on a country by country basis, using the Research Methodology Flow Chart in Appendix "A" as the framework. Each Zambezi Basin riparian state (including South Africa) will be dealt with in alphabetical order. The approach used is somewhat mechanical, but this is unavoidable given the methodology being used. There is no specific priority or international grouping evident at this stage of the research. A provisional hydrological / population risk assessment will be made, initially using the WBS and WSI data. Testing the hydrological / population risk profile (HPRP) and sectoral water efficiency (SWE) data against Lowi's variables, in order to identify the resultant political dynamics, will then refine this assessment. From this analysis a prioritisation of issues and the likely response of states to these will be made in Chapter 5.

This implies that there is a limited degree of duplication between certain of the material used in the current chapter and that discussed previously. This is unavoidable and the indulgence of the reader is requested in this regard. Where repeated, the current chapter goes into greater depth than was possible previously. Examples of this are data that were previously presented in Tables 4a & 4b, Table 6, Table 7 and Table 9, which are again reproduced (in part only). The one reason for this is to make the task easier for the reader by avoiding the need to constantly page backwards. The second reason is that the data concerned for each state is now going to be processed in a specific sequence in keeping with the methodology. By repeating the data, the reader is thus better able to monitor the process and therefore judge the ultimate findings as valid or invalid.

Another point must be made by way of introduction. The methodology tries to essentially focus on the implications of the hydrological predictions that water scarcity is likely to increase within the study area. Therefore the first and second subproblems are taken as having been validated at this time. The epistemological basis of this statement was presented in the conclusion of the previous chapter. Certain of the states will not be severely impacted on by the projected water scarcity however. This fact is evident in the favourable WBS and WSI data presented. Where this happens, it is largely due to the fact that those states are more water-abundant, so the population growth has a limited impact on water scarcity. In all cases, both the WBS and WSI will be presented that will reflect this. These two subproblems will not be discussed in greater detail as a result, but the data relating to them will be presented as they impact on the final analysis of each state. In reality, these two subproblems are extremely complex in nature. For example, an aspect of water scarcity is associated with global warming and climate change. Population dynamics are linked to demographic profiles, literacy levels, mortality and fertility rates, cohort groups etc. As such these are all clearly beyond the intended scope of this study and will only serve to create confusion by diverting the research effort. These two subproblems will again be discussed when the final conclusions are drawn.

ANGOLA

Subproblems 1 & 2: Water Scarcity and Population Growth

Recoverable Water Resources

The volume of recoverable water resources for Angola is 158 km^3 / yr^{-1} (Table 4a and Appendix "B"). This means that Angola has the highest level of recoverable water resources in the study area by far.

Population Growth

The civil war has created a significant internal migration dynamic. By the late 1980s 25% of the population were residing in urban areas bigger than 2 000 inhabitants. There are approximately 1,2 million internally displaced persons with approximately 500 000 that have fled to neighbouring states (Europa, 1996:145). The population growth figures for Angola are as follows (Table 6 and Appendix "B"):

TABLE 16

POPULATION GROWTH FOR ANGOLA

YEAR	MILLIONS
1982	7,43
2000	13,23
2025	24,47

Water Barrier Scale

From the above data, the number of persons / 'flow unit' for Angola can be calculated as follows (Table 4a and Appendix "B"):

TABLE 17

PERSONS / 'FLOW UNIT' FOR ANGOLA

1982	2000	2025
47	84	160

Hydrological / Population Risk Assessment

When these data are tested against the norm provided for by the WBS as presented in Appendix "D", it can be seen that Angola has a low level of water competition within its own borders. This corresponds to Position 1 (Well Watered Conditions) for 1982 and 2000, and Position 2 (Mid European Conditions) for 2025. The hydrological risk level is thus relatively low, but the population risk is evident in these data. When these WBS data are tested against Falkenmark's WSI Matrix presented in Appendix "D", the following data can be derived:

TABLE 18

WSI FOR ANGOLA

1982	2000	2025
11	11	12

This implies that Angola is potentially an abundant producer, capable of more than self-sufficiency with low level of technological inputs required. The HPRP is thus relatively low. The refugee problem created by the civil war increases this risk profile however.

Subproblems 3 & 4: Agricultural and Industrial Sector

The contribution to GDP of each sector indicates the overall economic "mix" of the country. The following sectoral data is provided by the World Bank (1996:18-20) and is presented as a percentage of total real GDP for the year at constant 1987 US Dollar prices:

TABLE 19

SECTORAL CONTRIBUTION TO GDP FOR ANGOLA

YEAR	1987	1988	1989	1990	1991	1992	1993	1994
Agric	13%	12%	12%	12%	13%	14%	13%	14%
Ind	41%	44%	43%	43%	43%	46%	52%	53%

Angola has been in a state of war since 1975. Prior to this it enjoyed a high-output economy with a rapidly expanding manufacturing sector. By the late 1980s 48% of government expenditure was on the purchase of arms, with some analysts placing this figure as high as 80% (Europa, 1996:146). The cost of the conflict has been so high that the government has effectively mortgaged future earnings from oil and diamonds for years to come (Africa Review, 1996:8). A peace agreement was entered into between the government and UNITA in May 1991 (Europa, 1995:355). As the peace process began to be felt, a significant upsurge in industrial activity is evident. This suggests a potential for industrialisation given the fact that 90% of all export earnings in 1990 came from oil (Africa Review, 1996:10) making Angola the major oil producer in the region, and the second largest producer of hydrocarbons on the continent after Nigeria (Europa, 1996:148). Angola is also rated as one of the most promising agricultural producers in Southern Africa, and is one of the richest in terms of mineral reserves (Europa, 1996:148). The peace dividend could thus be considerable.

Sectoral Water Efficiency Ratio

Only two data sets are available for water consumption. Table 9 only shows agriculture for 1987 expressed as a percentage of total consumption. The World Bank (1996:379) gives sectoral consumption for 1995 expressed as a percentage. These are as follows:

TABLE 20

SECTORAL WATER CONSUMPTION FOR ANGOLA

	TABLE 9	WORLD BANK
	1987	1995
Agric	76%	76%
Ind	n/a	10%

From this the SWE can be derived by comparing sectoral water consumption (Table 20) with sectoral contribution to GDP (Table 19). For the World Bank data, 1995 consumption statistics are compared to 1994 GDP contribution statistics (Table 19). This is as follows:

TABLE 21

SECTORAL WATER EFFICIENCY FOR ANGOLA

	1987	1994/5
Agric	76:13	76:14
Ind	? :41	10:53

There is a good correlation between the two data sets for agriculture, and a reasonable correlation for industry. From this it is evident that in the agricultural sector a relatively high portion of the total water consumed (> 75%) produces a relatively small contribution to the GDP (<25%). The agricultural SWE is low for both 1987 and 1995. Agriculture thus has a relatively low 'return to water', but Angola has a relatively high production capacity, much of which is rainfed. This indicates the potential for 'virtual water' as being considerable. In this context, given the fact that Angola has significant unused agricultural production potential, it can become a source for agricultural products within Southern Africa, thus supplementing the water shortages evident in other countries (Botswana, Namibia, South Africa) by means of the 'virtual water' content in these products. The SWE for industry is medium for 1987 and high for 1995. Angola also has the advantage of a considerable industrial potential given the unique hydrocarbon and mineral capacity already mentioned. Angola is thus in a favourable position to gain maximum benefit from the leverage effect of using water for industry, where traditionally the 'return to water' is higher. At least one avenue open for exploitation is hydroelectric power generation, some of which could be used for irrigation purposes of high value crops, for exportation to the other states in the study area.

Political Factors: Lowi's Variables

Resource Need / Dependence

Angola has the highest level of recoverable water resources in the region. It has access to five major river basins in Southern Africa (Table 1), two of which are the Zaire (Congo) and the Zambezi. The Zaire (Congo) River is more than eight times larger than the Zambezi, so this resource access is considerable. Angola also lies on the Cuanza Basin, and is in fact the only riparian on this resource, which is the fourth largest in the Southern African region. Evans (1997) notes that "the only countries with significant water resources left in Southern Africa are Zaire (now the Democratic Republic of Congo) and ... Angola". Consequently it can be concluded that regarding the Zambezi River as a resource, the need is low as there are a number of viable alternatives available. This statement is made in terms of strategic access to any one resource, in which Angola is in a favourable position, given its wide variety of choices and spatial availability.

Angola has considerable hydropower potential in excess of its own needs (Europa, 1996:150). In 1989 the Cambambe Dam on the Cuanza River had a generating capacity of 450 MW that fed Luanda's industry. Another plant is being constructed at Kapunda on the Cuanza River as part of the post-war reconstruction, which is scheduled to double the power generating capacity of Angola. Lobito and Benguela are supplied with electricity from the Lomaum Dam and the Biópio Dam on the Catumbela River with a capacity exceeding 206m kWh in 1973. The Lomaum Dam was destroyed by UNITA, but in 1987 a Portuguese consortium, supported by the Portuguese government, began reconstruction of this resource. The Matala Dam serves Lubango, Namibe and Cassinga, but this project is only a small part of the Angolan-Namibian scheme to harness the Cunene River. The Gove Dam on the Huambo reach of the Cunene River was completed with South African capital. A power station at Ruacaná Falls became operational in 1977. Hostilities and the political instability of the region impeded the operation however. The potential power output of this scheme is 1 000m kWh. Thus in terms of the generation of foreign earnings, Angola has considerable potential as the regional powerhouse. Both Namibia and Botswana are particularly dependent on Angolan water resources (refer to the analysis of Namibia and Botswana), which strengthens the overall Angolan hydropolitical position.

Rapport de Forces

Angola is a high order upstream riparian on the Zambezi River, a position that is traditionally strong in terms of shared resource conflicts. It has a considerable power potential (in a hydropolitical sense), as it lies upstream of both Botswana and Namibia. In the case of Namibia, it controls the headwaters of the Cunene River, which is a major resource for Namibia. To this end Webster (1996) noted that Namibia were aware of this situation and were thus eager to maintain cordial relations with Angola. In the case of Botswana, Angola controls the headwaters of the Kavango, which is a major resource for Botswana.

Angola has a number of harbour facilities, which are of importance to landlocked neighbouring states such as Zambia, and parts of the Democratic Republic of Congo. Given the significant agricultural potential (Europa, 1996:148) and natural levels of precipitation in Angola, it has the capacity to become a major exporter of 'virtual water' in the form of hydro-electric power and agricultural products to the Southern African region. Much of this remains only as a potential however, so the peace dividend can be regarded as being considerable.

Character of Riparian Relations

There have been tensions with Namibia as the result of alleged incursions along the southern border from UNITA controlled areas. The Angolan government supported SWAPO during its liberation struggle, so relations are generally cordial. There are no known riparian tensions. Angola is a signatory to 5 of the 22 major agreements between SADC States (Ohlsson, 1995a:59-60) other than the Protocol on Shared Watercourse Systems in the Southern African Development Community (SADC) Region. These are the ANJCC, PJTC, JCA, OKACOM, and SARCCUS (Appendix "E").

Conclusion

Angola has a low HPRP, and given the high level of availability of water, has the potential to become a major source of 'virtual water' in the form of power and agricultural produce to the Southern African region. The civil war has been devastating however, which implies three significant things. Firstly, Angola has the potential to generate migrants, which can become a regional problem. Secondly, there is the need for reconstruction and foreign assistance. Thirdly, the agricultural sector will be severely impacted for years to come as a result of the loss of infrastructure, internal displacement of people and the high presence of unexploded landmines. Angola will thus benefit directly from closer regional co-operation by receiving post-war assistance, and can also become a significant source of commodities that are in regional short supply, namely the 'virtual water' component of electricity and agricultural produce.

BOTSWANA

Subproblems 1 & 2: Water Scarcity and Population Growth

Recoverable Water Resources

The volume of recoverable water resources for Botswana is 9 km^3 / yr^{-1} (Table 4a and Appendix "B"). This means that Botswana has the lowest level of recoverable water resources in the study area by far (along with Malawi and Namibia).

Population Growth

The population growth figures for Botswana are as follows (Table 6 and Appendix "B"):

TABLE 22

POPULATION GROWTH FOR BOTSWANA

YEAR	MILLIONS
1982	0,86
2000	1,87
2025	4,06

Water Barrier Scale

From the above data, the number of persons / 'flow unit' for Botswana can be calculated as follows (Table 4a and Appendix "B"):

TABLE 23

PERSONS / 'FLOW UNIT' FOR BOTSWANA

1982	2000	2025
96	210	450

Hydrological / Population Risk Assessment

When these data are tested against the norm provided for by the WBS as presented in Appendix "D", it can be seen that Botswana had a low level of water competition within its own borders in 1982, even though it has a low level of recoverable water resources. The impact of the rapid population growth can be seen with relatively higher levels of competition evident in 2000 and 2025. This corresponds to Position 1 (Well Watered Conditions) for 1982, and Position 2 (Mid European Conditions) for 2000 and 2025. It can be anticipated that Level 3 (Water Stressed Conditions) will be reached by the mid-century. The hydrological risk level is thus classified as medium, as a result of the population risk that is evident in these data. When these WBS data are tested against Falkenmark's WSI Matrix presented in Appendix "D", the following data can be derived:

TABLE 24

WSI FOR BOTSWANA

1982	2000	2025
11	22	22

Botswana remains in a position of relative abundance, but is moving into a position where intermediate levels of technological inputs are required to maintain self-sufficiency, with the likelihood of high levels needed by mid-century. Some water pipelines are currently in use (North-South Carrier from the Letsibogo Dam near

Selibi-Pikwe to Gaberone) (Arnestrand *et al.*, 1993:32), and plans exist for significant upgrades in future (Botswana Water Project from the Zambezi) (Arnestrand *et al.*, 1993:57; Gilbu, 1997) as evidence of this. The point to note is the fact that although Botswana is an arid country, water competition is relatively low for two reasons. The first is the small population that is competing for access to the resource. The second is a geological reason, with Botswana having a relatively large supply of underground water in deep ancient aquifers that enable it to withstand drought better than neighbouring states (Arnestrand *et al.*, 1993:11). These aquifers have a slow recharge time, so their resources cannot be used for agriculture. Groundwater is a major source of supply, maintaining some 80% of the population and most livestock (MacDonald *et al.*, 1990b:2.4). This has led to a successful policy of "conjunctive use", which means that in wet years, proportionally more surface runoff is used, allowing for groundwater aquifer recharge. During dry years, the groundwater is abstracted at a rate exceeding aquifer recharge, and is called "groundwater mining" (Arnestrand *et al.*, 1993:33). This is not sustainable in the long-term so alternatives will have to be found, probably in the form of surface water IBTs, to cater for population growth. This is the primary reason for the North-South Carrier. The HPRP is thus low for 1982 and medium for the years 2000 and 2025.

Subproblems 3 & 4: Agricultural and Industrial Sector

The contribution to GDP of each sector indicates the overall economic "mix" of the country. The following sectoral data is provided by the World Bank (1996:18-20) and is presented as a percentage of total real GDP for the year at constant 1987 US Dollar prices:

TABLE 25

SECTORAL CONTRIBUTION TO GDP FOR BOTSWANA

YEAR	1987	1988	1989	1990	1991	1992	1993	1994
Agric	5%	7%	6%	6%	6%	6%	6%	5%
Ind	57%	53%	54%	51%	50%	48%	46%	46%

Botswana has almost no history of internal conflict, at least during this century. Its economic growth has been remarkable, with Botswana becoming the first state in sub-Saharan Africa to contribute to the IMF (Europa, 1995:604). Botswana recorded one of the highest growth rates in the world (Europa, 1993:560) during the last decade, coming from the dubious position of having been one of the 20 poorest countries in the world at independence in 1966 (Europa, 1996:183). The industrial strength (with strong support from the mining sector) is clearly evident, although a steady decline in GDP contribution is noted. This data is slightly distorted by the inclusion of the diamond industry. This is partly illustrated by the fact that 13% of the population during the period 1985/8 were employed in the industrial sector (Table 13). In contrast, the agricultural contribution to GDP has remained fairly constant.

Sectoral Water Efficiency Ratio

Two data sets are available for water consumption. Table 9 only shows agriculture for 1987 expressed as a percentage of total consumption. The World Bank (1996:379) gives sectoral consumption for 1995 expressed as a percentage. These are as follows:

TABLE 26

SECTORAL WATER CONSUMPTION FOR BOTSWANA

	TABLE 9	WORLD BANK
	1987	1995
Agric	85%	48%
Ind	n/a	20%

From this the SWE can be derived by comparing sectoral water consumption (Table 26) with sectoral contribution to GDP (Table 25). This is as follows:

TABLE 27

SECTORAL WATER EFFICIENCY FOR BOTSWANA

	1987	1995
Agric	85:5	48:5
Ind	? :57	20:46

There is a good correlation between the contribution side of the two data sets for agriculture, and a reasonable correlation for industry. From this it is evident that in the agricultural sector, a relatively high portion of the total water consumed (>75% in 1987 and almost 50% in 1995), produces a relatively small contribution to the GDP

(<10%). Agriculture thus has an extremely low 'return to water', but the result is an anomaly for this sector as the SWE is low for 1987 but high for 1995. Industry has a better 'return to water' and the SWE is high for 1987 and medium for 1995. The SWE data for Botswana is clearly problematic. Significantly, Botswana has recently given up its strategy of national food self-sufficiency and has adopted a policy of 'food security' instead (Arnestrand *et al.*, 1993:31). This decision seems justified, indicating the potential benefit for 'virtual water' importation as being considerable. Given the history of economic growth, rapid industrialisation will likely yield disproportionately large benefits. Botswana is thus in a favourable position to gain maximum benefit from the leverage effect of using water for industry, where traditionally the 'return to water' is higher, especially where there is a national culture of survival with low water availability and drought tolerance.

Political Factors: Lowi's Variables

Resource Need / Dependence

Botswana has the lowest level of recoverable resources in the study area. It has access to three shared river basins (Table 1). In the order of magnitude these are the Zambezi, Kavango and Limpopo. There are no perennial rivers rising in Botswana. Available supplies in south-eastern Botswana are only sufficient until the end of this century. A number of studies are being conducted for the expansion of the North-South Pipeline to transfer water from the better watered northern parts. The North-South Water Carrier Project is the biggest construction project in the history of the country (Economist Intelligence Unit, 1996e:16) indicating the level of resource need. The primary supply to this pipeline will be a dam on the Lower Shashe or Moutloutse River. The complexity of the project is evident from the map in Figure 13.

In approximately 25 years all available water in eastern Botswana will be utilised. Transfers will then be required from the far north, originating in either the Kavango or Chobe/Zambezi Rivers (MacDonald *et al.*, 1990b:2.1). Namibia also intends to abstract water from the Kavango, meaning that there could be tension between the two states over this issue in future. A National Water Master Plan (NWMP) has been commissioned. International rivers will have to be used after 2020, so the NWMP factors in sharing water with neighbours (Gilbu, 1997) as part of the overall policy. Groundwater, although heavily used to supplement surface water, is meagre with large parts of the country receiving no significant groundwater aquifer recharge (Arnestrand *et al.*, 1993:47). Reliance on the three shared rivers is thus extremely high.

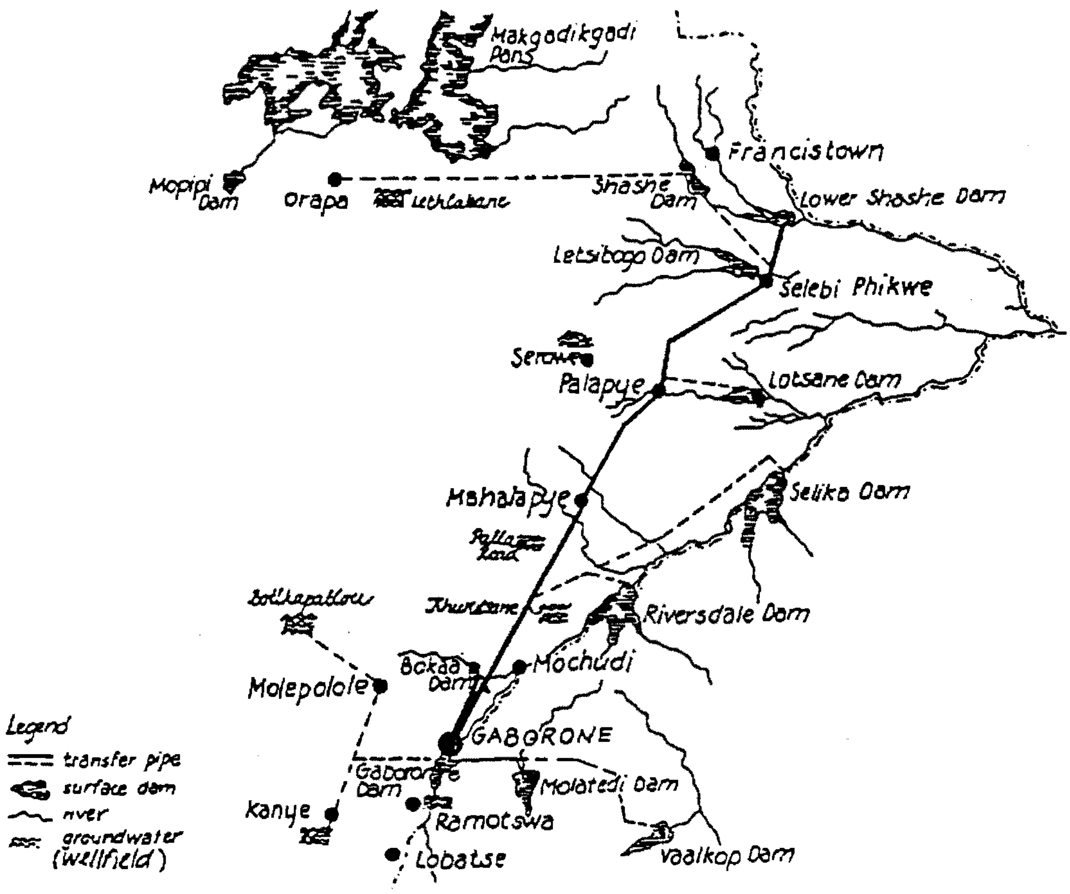


Figure 13. Map of the North-South Carrier (Arnestrand *et al.*, 1993:32).

The Chobe Enclave Pre-feasibility Study concluded that the irrigation potential is negligible due to poor soil types and the fact that the Chobe River is not a reliable water source (MacDonald *et al.,* 1990b:2.6). SMEC's Southern Okavango Study identified a net irrigation potential of about 10 000 ha in the Lake Ngaari and Nhabe River areas, with an additional possibility of irrigating 5 000 ha in the Nokaneng Flats area (MacDonald *et al.,* 1990b:2.6). The problem here is that Namibia is intending to abstract water from the Kavango which will jeopardise this. A project to supply water from the Southern Okavango Delta region was suspended in 1991 following pressure from international environmentalists (Europa, 1996:185). Shortages of water have been identified as the main hindrance to the development of Botswana's other natural resources (Europa, 1996:180).

MacDonald *et al.,* (1990b:2.7) recognise the need to develop the regional water resources due to the fact that groundwater is reaching the limit of its potential. The resource need can thus be said to be critical for Botswana. A unique environmental fact exists within Botswana that could become politically and economically significant in future, if correctly exploited in a sustainable manner. The northern part of Botswana is characterised by the Kalahari Depression. This area is the reason why the Kavango River disappears into the sands of the Kalahari Desert in a unique ecosystem called the Okavango Swamps. It is also the reason for the existence of the Makgadikgadi Salt Pans. The Cuando/Linyati River, a tributary of the Zambezi and border between Botswana and Namibia, traverses this flat featureless landscape.

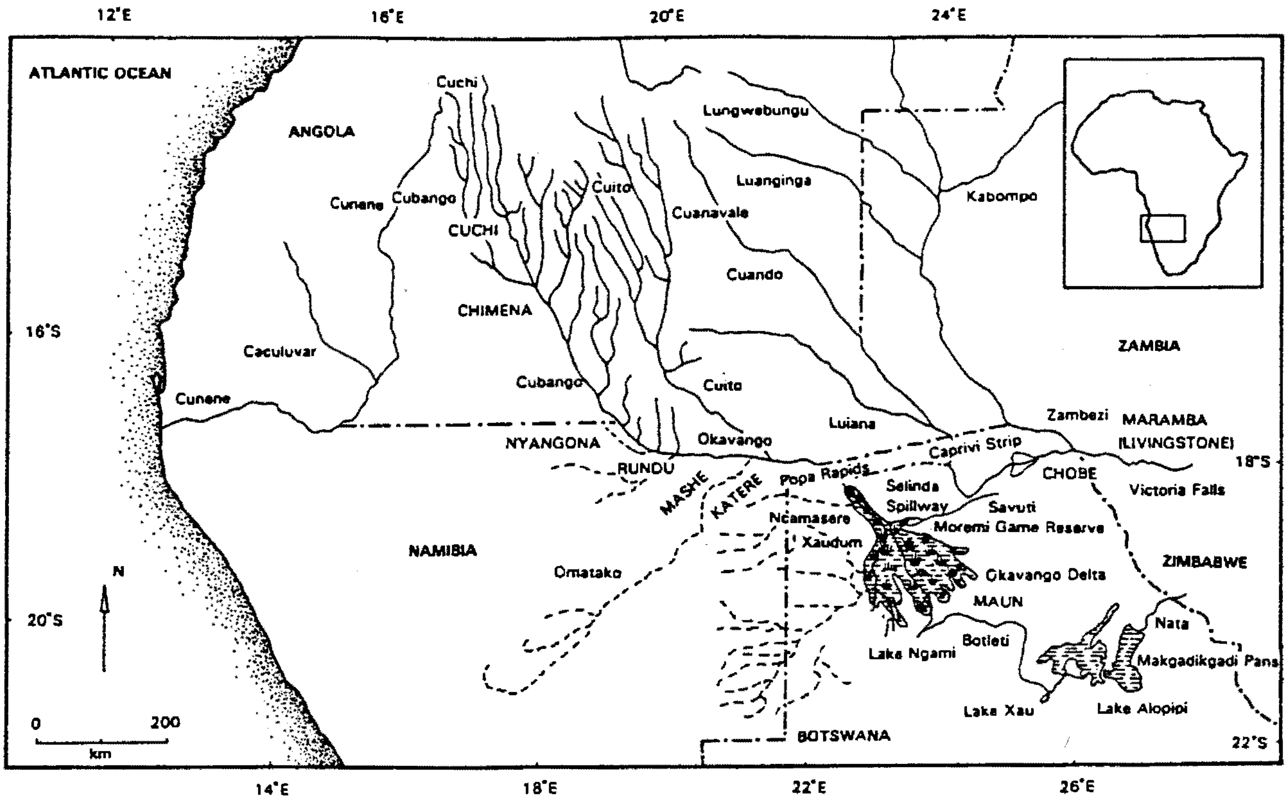


Figure 14. Simplified Map of the Okavango Delta System (Davies *et al.*, 1993:94).

The significance of this geomorphology is the fact that the rivers in that area tend to become flood plains. These flood plains exist south of the Caprivi Strip in the Chobe, Savuti and Moremi areas. There is a riparian dispute between Botswana and Namibia over the Kasikili-Sedudu Island. This island is situated between the two states, in the Caprivi Strip. This dispute has been linked to an arms build-up between the two states concerned. While this dispute is relevant to the role of the Chobe River, the causes differ from the ecological problems that development of the Chobe River present. This is analysed in greater detail in Chapter 4.

Davies (1996a) notes that at times of exceptionally high flow, the Zambezi River pushes back up its tributaries at the Chobe and floods into the Savuti. There is thus a spatial link between the two river basins (Zambezi and Kavango) at this unique point. As a result of this the ecosystem is somewhat unique and extremely fragile, so exploiting this water resource is highly problematic. Assuming however that the ecological issues could be satisfactorily dealt with, then this offers a unique opportunity for Botswana to gain strategic long-term access to water that is vitally needed. Alexander (1996) states the following:

> "The Zambezi River bifurcates immediately upstream of the Mambova Rapids where it exits from the (Kalahari) depression. The western channels flow into the Chobe River upstream of the rapids. An abstraction point in the vicinity of the rapids, is the most favourable site along the whole of the Zambezi River from an engineering point of view, *but the most complex politically as the boundaries of Namibia, Botswana, Zambia and Zimbabwe all meet at a single point at the confluence of the Chobe and Zambezi Rivers* downstream of the rapids. It is also the site most likely to cause disturbances in the complex aquatic ecosystem upstream of the rapids. The optimum site in this area is on the Chobe River immediately upstream of the rapids. The abstraction works could be located wholly within Botswana, and the natural storage capacity of the (Okavango) swamps would provide more than sufficient balancing storage without causing perceptible decrease in water levels within the swamps" (emphasis added).

It must be noted however, that while this is entirely feasible from an engineering viewpoint, the issue raises extremely vigorous, and in the opinion of the author justified, debate amongst ecological researchers. The basic premise of this current research is that it makes political sense to have sustainability as a fundamental 'core value' so the author supports any multidisciplinary approach to the solution of the complex socio-political problems that face the region. Non-sustainable projects tend to cause larger long-term problems that they were originally designed to solve. This particular aspect is likely to be revisited by the government of Botswana, so it is probably going to remain an issue between environmentalists and developers.

Rapport de Forces

Plans are in existence for the abstraction of water from the Kavango upstream of Botswana by both Angola and Namibia. These are outside the control of Botswana and could thus be detrimental to the national interest of Botswana (MacDonald *et al.*, 1990b:2.2). Botswana is located on the downstream reach of the Kavango River, which is both a critical resource and traditionally a weaker riparian position to be in.

The same holds true for the Cuando River, a tributary of the Zambezi, which forms the actual border with Namibia along the Caprivi Strip. This is where the disputed Kasikili-Sedudu Island that is discussed in the next chapter is located. This again is a traditionally weaker riparian position. Water resources in the Limpopo Basin have been heavily developed by South Africa, often with undue regard for the effect on Botswana, to such an extent that the river ceased to flow for large stretches on the common South African - Botswana border during the 1987 drought (MacDonald *et al.,* 1990b:2.2).

Botswana holds a vital strategic position in regional hydropolitical terms, as the access route for South Africa to the waters of the Zambezi, should South Africa consider this strategic option. This can result in a type of "multiplier effect", with Botswana thus increasingly gaining the status of "balancer" of the regional power, as it could theoretically deny South African access to the water. This can be seen in Figure 15.

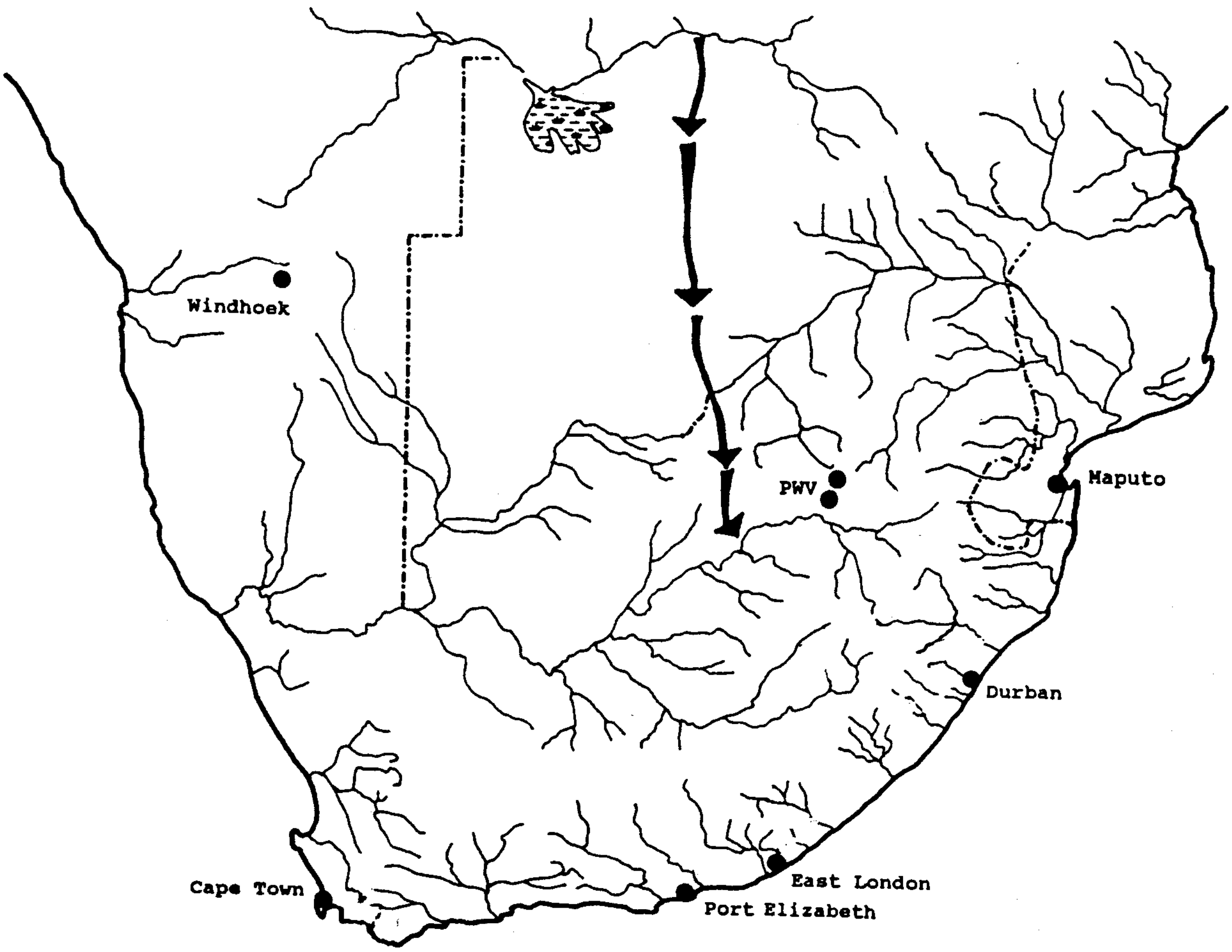


Figure 15. Proposed Routing of the Zambezi Aqueduct (Davies *et al.*, 1993:143).

The potential that the Zambezi Aqueduct has for the development of Botswana is considerable in its own right. A canal in the more densely populated eastern parts of Botswana would be ideally placed to supply water to the domestic, industrial, thermal power and mining sectors (Pitman *et al.*, 1997:142). In addition this canal could be used for the transportation of goods. As noted in the previous chapter, evaporative losses would be considerable however. Botswana is landlocked and thus has a need to gain strategic access to harbours. This is done via South Africa and Zimbabwe. There are plans to use Namibia once the infrastructure is in place (Europa, 1995:605). This fact forces Botswana into a relationship of goodwill and at times infrastructural dependency. Despite the reduction in regional tensions, military spending remains high, with the Botswana Defence Force (BDF) being allocated 11% of the total capital expenditure of the Seventh National Development Plan (NDP VII) covering 1991-97. Most of this was for an airforce base at Mapharangwane, 80-km west of Gaberone. This is known as Operation Eagle because of the unspecified amount of US Military assistance (Africa Review, 1996:16) that was given. This has created the perception of unease in Namibia (Webster, 1996) and subtle questions are being asked about the ultimate purpose of this military build-up.

Character of Riparian Relations

There are generally good relations with post-apartheid South Africa (Africa Review, 1996:16). Botswana is dependent on South African transport routes, until the completion of the planned road linking Botswana with Walvis Bay in Namibia (Europa, 1995:605). Lowi (1990:12) notes that perceptions form an important component of this variable. To this end the Kasikili-Sedudu dispute provides some evidence of the role of perceptions. For this reason it is analysed in greater detail in the next chapter. Webster (1996) informed the author that the perception in Namibia was that the BDF build-up was linked to resource scarcity and the possibility of a future resource conflict in the region. Emerging from the Kasikili-Sedudu dispute, hostility between Botswana and Namibia continued into 1994 regarding the BDF construction of the Molepole air base, the size and expense of which were controversial even in Botswana itself (Europa, 1995:604). The reader is referred to the case study of the Kasikili-Sedudu dispute in Chapter 4 for more details.

Botswana is a signatory to 5 of the 22 major agreements within SADC (Ohlsson, 1995a:59) other than the Protocol on Shared Watercourse Systems in the Southern African Development Community (SADC) Region. These are the OKACOM, LBPTC, JPTC, JPWC and SARCCUS (Appendix "E"). Botswana is currently pursuing another agreement with Zimbabwe on the Ramokgwebana River in the east (Gilbu, 1997).

Efforts at Conflict Resolution

Botswana provides evidence of Lowi's fourth variable. This is relevant to the research as it relates to the idea of improved policy co-ordination within a regional context. Botswana President Quett Masire and Zimbabwean President Robert Mugabe intervened in the 1994 Lesotho crisis to restore constitutional government and avert bloodshed (Africa Review, 1996:16). South Africa also played a role in this regard on behalf of the OAU. The Kasikili-Sedudu dispute was referred to the International Court of Justice in March 1995 for resolution (Africa Review, 1996:16). This indicates that there is an inherent normative value system that shows a respect for peaceful conflict resolution. The mediation initiatives of President Mugabe failed in the Kasikili-Sedudu case however, as noted in the next chapter. Botswana does not play a major role in the activities of the SADC Organ on Politics, Defence and Security that was created in 1996 as a regional conflict-resolution mechanism however.

The American influence can become a factor in regional conflict resolution terms in the future and the USA could be regarded as a third party. At present there are two conflicting dynamics at work in this regard, so a prediction is difficult to make. On the one hand, the USA made a substantial contribution to the Mapharagwane airbase. On the other hand there are indications that the USA wishes to refrain from military incursions into Africa since the failed initiative in Somalia resulted in the death of American soldiers and an unfavourable domestic press for the Clinton administration. Warren Christopher, the US Secretary for State, has since called on Africa to establish its own peacekeeping force. This could impact on the strategic position of Botswana, specifically if South Africa should decide to gain access to the Zambezi River by funding a pipeline through Botswana.

Conclusion

Botswana is a successful country when measured against the criteria of a developing country. It is also extremely water resource scarce, with a critical need for secure strategic access to water. The militarisation of the state should not be overlooked in terms of Lowi's variables. The role of the USA could be regarded as significant, and could allow Botswana to become the "balancer" of regional hydropolitical power in the future. This depends on two issues. Firstly, the changed role that the USA has defined for itself in Africa; and secondly whether South Africa chooses to pursue the option of developing a pipeline to the Zambezi River via Botswana.

At least one dispute that has resulted in armed intervention (Kasikili-Sedudu) involves riparian related issues. Lowi (1990:12) indicates the value of perceptions in the formulation of foreign policy, and to this end there is a perception, at least in Namibia but possibly elsewhere in the study area, that Botswana is arming itself for some future conflict that is possibly resource based. It can thus be concluded that while Botswana is in a traditionally weak riparian position regarding existing shared water resources, the *rapport de forces* position based on the combined geographic location, economic and military capacity is somewhat stronger. Relative to South Africa, it can be argued that Botswana could become extremely strong if the proposed Zambezi Aqueduct were to go ahead, as this would make Botswana a higher order riparian than South Africa. Should South Africa successfully implement a 'virtual water' strategy, and thus not need the Zambezi Aqueduct, then this argument would no longer be valid.

Botswana has considerable potential as a political ally with South Africa in future negotiations regarding access to the waters of the Zambezi River. Given the reality that South Africa is not a Zambezi riparian state (and therefore has no automatic legal right to the waters of this river), and that other riparian neighbours (Zimbabwe) are not in a suitable position from an engineering viewpoint to provide the least-cost option, Botswana becomes the best alternative.

The strategic advantage for Botswana increases when one considers the mooted intention of South Africa, albeit tentatively at this stage, to divert the waters from the Lualaba River in the Zaire (Congo) Basin. In this regard there is a coincidence of national interests; both Botswana and South Africa have a need to gain access, as in this case the water will probably be diverted down the Zambezi *past* Botswana. The significance here is that Botswana's main Zambezi access is via the Cuando/Linyati River, and not directly from the Zambezi River itself. Botswana could thus potentially miss the benefits of this increased flow. Botswana is thus likely to only gain access to this Lualaba River water with the support of South Africa. Botswana, as a reasonably prosperous state, can become the target for migrants and will thus have an interest in combating this problem in terms of joint policy.

Regarding the issue of food self-sufficiency, the success of this new policy is yet to be tested. It is therefore necessary at this stage to distinguish between the policy decision (which has already been taken) and the final implementation of this, which may be at odds with the intended objective. The data support the wisdom of the policy choice, but it is still too premature to pronounce the results a success. In terms of the Karshenas model used by Allan, it can be said that Botswana has made the transition from a 'common' trajectory to that of a 'precautionary' developmental trajectory, at least in terms of intention, and is slightly ahead of South Africa in this regard. Botswana has thus adopted the 'virtual water' paradigm as a development option out of a combination of necessity and economic strength.

Botswana seems to have recognised the low return to water from agriculture as a problem and has begun making the necessary policy shift. Given the drought tolerance that is evident, along with the policy shift, it can be concluded that Botswana is moving in the right direction. Unfortunately the SWE data was anomalous, so a conclusion regarding the potential benefits of 'virtual water' cannot be drawn with confidence.

MALAWI

Subproblems 1 & 2: Water Scarcity and Population Growth

Recoverable Water Resources

The volume of recoverable water resources for Malawi is 9 km^3 / yr^{-1} (Table 4a and Appendix "B"). This means that Malawi has the lowest level of recoverable water resources in the study area by far (along with Botswana and Namibia).

Population Growth

The population growth figures for Malawi are as follows (Table 6 and Appendix "B"):

TABLE 28

POPULATION GROWTH FOR MALAWI

YEAR	MILLIONS
1982	6,57
2000	11,7
2025	23,19

Water Barrier Scale

From the above data, the number of persons / 'flow unit' for Malawi can be calculated as follows (Table 4a and Appendix "B"):

TABLE 29

PERSONS / 'FLOW UNIT' FOR MALAWI

1982	2000	2025
730	1 300	2 600

Hydrological / Population Risk Assessment

When these data are tested against the norm provided for by the WBS as presented in Appendix "D", it can be seen that Malawi has a very high level of water competition within its own borders. The impact of the rapid population growth can be seen. This corresponds to Position 3 (Water Stressed Conditions) for 1982, Position 4 (Chronic Scarcity Conditions) for 2000 and Position 5 (Beyond 'Water Barrier') in 2025. This gives clear evidence of the impact of a growing population competing for a finite water resource, as Botswana has the same recoverable resources available, but remains in a favourable position due to the smaller population base in that country. The demographic profile of Malawi indicates that approximately 45% of the population are under the age of 15 years with only 11% living in urban areas (MacDonald *et al.*, 1990c:1.1). This implies that the population is yet to reach its most explosive phase, with a probable resultant increase in the amplitude of the migratory push-factors. Given the small physical size and relatively high population, Malawi has a population density of 171 people per km^2 of arable land at present (Economist Intelligence Unit, 1996f:10). This gives Malawi the highest population density in the study area and one of the highest in Africa as a whole. The HPRP is thus high as a direct result of the population component of the risk equation. When these WBS data are tested against Falkenmark's WSI Matrix presented in Appendix "D", the following data can be derived:

TABLE 30

WSI FOR MALAWI

1982	2000	2025
13	24	25

Malawi is in a position of scarcity, but is moving into a position where severe problems are to be expected. Intermediate levels of technological inputs are required to maintain self-sufficiency. The significant point to note from this risk profile is the fact that Malawi has the potential to become the source of both environmental and economic refugees in future. It is already plagued by this problem, ostensibly by an influx of refugees from Mozambique, which in 1992 had reached a magnitude of some one million (Europa, 1995:1968). The current crisis in the African Great Lakes region can cause additional problems for Malawi, adding to this already high-risk profile, by providing an additional refugee load. The HPRP is high for the years 1982 and 2000, and very high for the year 2025.

Subproblems 3 & 4: Agricultural and Industrial Sector

The contribution to GDP of each sector indicates the overall economic "mix" of the country. The following sectoral data is provided by the World Bank (1996:18-20) and is presented as a percentage of total real GDP for the year at constant 1987 US Dollar prices:

TABLE 31

SECTORAL CONTRIBUTION TO GDP FOR MALAWI

YEAR	1987	1988	1989	1990	1991	1992	1993	1994
Agric	32%	34%	31%	29%	31%	25%	35%	27%
Ind	17%	18%	18%	19%	19%	20%	17%	20%

Development of Malawi's extremely limited industrial base was accorded priority at independence (Europa, 1996:577) in 1964. This has not met with any significant success, and the agricultural dominance is clearly still evident. The apparent improvement for agriculture and decrease for industry in 1993 cannot be explained with reference to the data available. Whilst this is unfortunate, it makes little impact on the overall picture being presented.

Sectoral Water Efficiency Ratio

Only two data sets are available for water consumption. Table 9 only shows agriculture for 1987 expressed as a percentage of total consumption. The World Bank (1996:379) gives sectoral consumption for 1995 expressed as a percentage. These are as follows:

TABLE 32

SECTORAL WATER CONSUMPTION FOR MALAWI

	TABLE 9	WORLD BANK
	1987	1995
Agric	49%	86%
Ind	n/a	3%

The SWE can be derived from this by comparing sectoral water consumption (Table 32) with sectoral contribution to GDP (Table 31). This is as follows:

TABLE 33

SECTORAL WATER EFFICIENCY FOR MALAWI

	1987	1995
Agric	49:32	86:27
Ind	? :17	3:20

There is a fair correlation between the contribution side of the two data sets for agriculture, and a good correlation for industry. Consumption figures vary somewhat however. The industrial statistics for 1995 are revealing. The 3% of the water that was consumed by this sector contributed 20% to the GDP. This is a low industrial SWE. This supports the 'virtual water' rationale. It is evident that in the agricultural sector, a relatively high portion of the total water consumed (almost 50% in 1987 and >75% in 1995) produces a relatively smaller contribution to the GDP (25-50%). This is an anomaly however as for 1987 it is high but for 1995 it is low. Thus we have the situation where agriculture, which is known to have an extremely low 'return to water', is the dominant sector of the economy. This is similar to Mozambique. Malawi is thus clearly a "water inefficient" state, with little prospect of change evident in the future.

Political Factors: Lowi's Variables

Resource Need / Dependence

Malawi has the lowest level of recoverable resources in the study area with access to three of the major river basins in terms of Table 1. These are the Zambezi, Lilongwe and Shire rivers quoted in order of magnitude. This is misleading however, as both the Shire and Lilongwe are sub-basins of the Zambezi, and therefore are not entirely independent. All are thus an integral part of the Zambezi Basin. According to MacDonald *et al.,* (1990c:2.1) much of the available surface water lies in Lake Malawi and the Shire River, with the other rivers generally being highly seasonal in character. Significantly, 60% of the inflow to Lake Malawi is lost by evaporation and is thus not available. As indicated previously, Malawi has a high HPRP with an agricultural based economy that is largely rainfed reliant. The Malawi economy is highly vulnerable to the climate, being dependent on tobacco, tea and sugar for 95% of all export earnings (Africa Review, 1996:116).

The National and Shire Irrigation Study Report in June 1981 indicated a potential for 100 000 ha of irrigation, mostly of sugarcane and rice. This would utilise 60% of the mean available resources and would reduce hydropower generation capacity on the Shire River (MacDonald *et al.,* 1990c:2.8). This is significant in terms of the 'virtual water' paradigm as the Shire River alone has a potential generation capacity of 455 MW (MacDonald *et al.,* 1990c:2.14), with an additional 212 MW from the Bua River and South Rukuru. It makes more long-term sense to rather export the 'virtual water' content of excess hydroelectric power which has a higher cash value, which could then be used to buy the equivalent crops that would have otherwise been grown with the same resource. There is heavy dependence on groundwater abstraction, mostly for domestic consumption (17,3 million m^3 / yr^{-1})(MacDonald *et al.,* 1990c:2.5).

Given the large population base, a problem that is exacerbated by refugees, and the fact that Malawi is a physically small country, it has the highest population density in the region with 107,3 persons / km^2 (compared to 2,6 persons / km^2 for Botswana and 2,4 persons / km^2 for Namibia, both of which have the same amount of recoverable surface water) (Ohlsson, 1995a:33). In terms of calculations by Vaclav Smil, less than 0,07 ha of land per person in a country renders that country incapable of feeding their own population, without intensive use of technological inputs. Malawi will probably reach this critical threshold by 2025 (Ohlsson, 1995a:34) to be followed shortly thereafter by Mozambique (which is already a source of refugees in Malawi). A national sample survey of agriculture in 1985/6 showed that 86% of rural households have less than 2 ha and 55% have less than 1 ha of land (Economist Intelligence Unit, 1996f:10). The higher technological inputs are unlikely to be afforded by the Malawi economy, so the prospects for a catastrophic environmentally induced crisis are good.

It can thus be said that the water resource need is critical for Malawi in terms of the Zambezi Basin.

Rapport de Forces

Malawi occupies a high order riparian position that is traditionally a stronger one. The high HPRP and level of economic decline reduce the potential impact of this in hydropolitical terms however. As already indicated, Malawi is economically weak and resource-poor, and the potential for environmental catastrophe is likely to increase in direct proportion to the population growth and resultant land scarcity and over-exploitation. Malawi had troops in Mozambique to protect the railway line to Nacala (Europa, 1995:1968) and it had a history of strained relations with Mozambique and Zimbabwe under the Banda regime. Malawi could increase its power position within the study area by harnessing whatever hydropower capacity it can spare and thus becoming an energy exporter, but the magnitude of this is not vast in comparison with water-rich states like Angola and Zambia. The *rapport de forces* situation of Malawi is thus likely to remain relatively weak on balance.

Character of Riparian Relations

Economically and militarily, Malawi was in the South African sphere of influence until 1994, which was a source of considerable tension with other countries in the study area (Europa, 1995:1968). This fact is likely to be remembered by the new political elite in Pretoria, but the overthrowal of Dr. Banda can possibly obliterate this political legacy in time. President Mandela of South Africa paid tribute to President Banda on the death of the latter.

There is a history of strained relations with Mozambique as a result of the widely held belief in Mozambique that the Banda regime was supporting RENAMO rebels. The role of perceptions in this regard is worth noting in terms of Lowi's framework. Following the death of President Samora Machel in an aircraft crash in 1986, the South African government claimed that documents discovered in the crash wreckage revealed a plot by Mozambique and Zimbabwe to overthrow the Banda regime (Europa, 1995:1968). Both Zimbabwe and Mozambique denied the protests from Malawi. This could have been a case of political manipulation by South Africa, eager to maintain its ally in Malawi, by feeding the threat perception already held by the political elite in that country. In December 1986, Malawi and Mozambique signed an agreement on defence and security matters that led to the deployment of Malawi troops to protect the railway line to Nacala. These troops were withdrawn by 1993. The apparent continued presence of Malawi Young Pioneers (MYP) in Mozambique, allegedly being housed in old RENAMO bases, was a concern of the Muluzi administration as recently as 1995.

There is an unresolved border (riparian) dispute between Malawi and its neighbours over Lake Malawi. This is relevant as Lake Malawi falls within the Zambezi Basin. The dispute is analysed in some detail in the next chapter. This dispute is based on the claim by Tanzania that the border is the median line of Lake Malawi, and not the Eastern Shore. This implies the right of Tanzania to "enjoy access to the waters of the lake and the use of its resources" (Day, 1987:154). Malawi responded in September 1968 (Day, 1987:156) when President Banda said that,

> "the real boundaries [of Malawi] are 160-km north of the Songwe River [Malawi's present northern border with Tanzania]. To the south it is the Zambezi River [in Mozambique]. To the west it is the Luangwa River [in Zambia], and to the east it is the Indian Ocean".

This is based on the traditional boundaries of the Maravi Empire. Tanzania decided not to respond to these claims so the issue remains unresolved but not actively debated. Zambia did not take President Banda's claim seriously at that time.

Since then, there has been a dispute between Malawi and Zambia, arising from the detention on 11 January 1982, of 10 Zambian nationals for allegedly straying into Malawi. This was resolved, but a year later Zambian villagers around Nakonde complained of being harassed by Malawian police and Young Pioneers, and that Malawian's had begun cultivating crops in Zambian territory. A joint commission was subsequently convened and the dispute was resolved in August 1986 when Zambia withdrew the claim of the disputed land (Day, 1987:157).

These disputes are not significant in order of magnitude. The relevance of these border disputes is that they show that Malawi has displayed a propensity to raise such issues in the past. Given the known high population density of Malawi, it also suggests that at some time in the future, there will be a point reached where existing Malawi nationals will not be able to find sufficient land on which to subsist. In fact, this issue of land occupation was a factor in certain of the above-mentioned disputes. In this sense, the issue revolves around resource access, with water and land becoming linked. While the dispute surrounding the demarcation of the border in Lake Malawi seemed to just disappear, it may again become an issue due to the population pressures that are evident. One implication of the Lake Malawi dispute, is that it will give Malawi nationals that live off the proceeds of fishing access to the entire lake, rather than just a portion, as is the current situation. Certainly in terms of military capacity, Malawi seems powerless to translate these disputes into serious conflict however.

Malawi is a signatory to 4 of the 22 major agreements within SADC (Ohlsson, 1995a:60) other than the Protocol on Shared Watercourse Systems in the Southern African Development Community (SADC) Region. These are the JCC, PCC, PJCC and SARCCUS (Appendix "E").

Conclusion

Malawi is a relatively weak state, under severe pressure of resource-scarcity that is induced by population growth. This is likely to take Malawi beyond the threshold of self-sustainability by 2025. This position is being further weakened by refugee migration, first from Mozambique and more recently from Rwanda and Burundi. Malawi thus has the potential to become the source of regional instability. The political impact on the study area is likely to be twofold. Firstly, Malawi is likely to become a significant drain on the region, siphoning off vital resources that could be used elsewhere and generally acting as a severe brake to regional economic development plans. Secondly, Malawi has the potential to become a vast reservoir of migrants, cut off from the vital access to resources on which survival depends, and who are forced to move to areas of perceived wealth and prosperity. There is an unresolved riparian dispute involving the resources of Lake Malawi. In the event of the predicted increase in population pressure, with the resultant pressure on natural resources, this could erupt into conflict with Tanzania. This could in turn trigger off the dormant aspirations of a historical "Maravi Empire" border that claims access to the Luangwa River in Zambia and the Zambezi River in Mozambique.

Regarding both the agricultural and industrial SWE Malawi can be regarded as having a low efficiency. This implies that limited benefit will be had from the adoption of a 'virtual water' development model, as the industrial base is weak, so the gearing will not be present in sufficient magnitude to finance 'virtual water' imports in a viable manner.

MOZAMBIQUE

Subproblems 1 & 2: Water Scarcity and Population Growth

Recoverable Water Resources

The volume of recoverable water resources for Mozambique is 58 km^3 / yr^{-1} (Table 4a and Appendix "B"). This means that Mozambique has the fourth largest level of recoverable water resources in the study area.

Population Growth

The demographic profile is unique as 46% of the population are below the age of 15 years (Economist Intelligence Unit, 1996a:9). This is significant in relation to the rest of the data presented as it implies a high potential fertility level. The population growth figures for Mozambique are as follows (Table 6 and Appendix "B"):

TABLE 34

POPULATION GROWTH FOR MOZAMBIQUE

YEAR	MILLIONS
1982	11,1
2000	21,8
2025	39,71

Water Barrier Scale

From the above data, the number of persons / 'flow unit' for Mozambique can be calculated as follows (Table 4a and Appendix "B"):

TABLE 35

PERSONS / 'FLOW UNIT' FOR MOZAMBIQUE

1982	2000	2025
190	380	690

Hydrological / Population Risk Assessment

When these data are tested against the norm provided for by the WBS as presented in Appendix "D", it can be seen that Mozambique has a moderate to high level of water competition within its own borders. These correspond to Position 2 (Mid European Conditions) for 1982 and 2000, and Position 3 (Water Stressed Conditions) for 2025. The impact of the population growth after the protracted civil war is underestimated in the opinion of the author. This view is based on the personal observations of the author who spent time in rural Mozambique during 1993. These cannot be adequately quantified, but at least 70% of the women soldiers that were then being demobilised and who were interviewed by the author, expressed the view that they had fallen behind their female civilian cohorts, who had produced anything up to five children during the same period of time. While this sample is clearly too small to be valid, the impression left was that their expectation was thus that they would fall pregnant almost immediately after demobilisation, and may have produced two or three children since. When these WBS data are tested against Falkenmark's WSI Matrix presented in Appendix "D", the following data can be derived:

TABLE 36

WSI FOR MOZAMBIQUE

1982	2000	2025
12	12	23

Mozambique is in a theoretical position of abundance (excluding the impact of the protracted civil war), but is moving into a position where scarcity problems are to be expected with intermediate levels of technological inputs being required to maintain self-sufficiency. The author personally witnessed massive hunger during 1993, with foreign food aid being needed for basic survival in certain rural parts of Mozambique.

This risk profile must be interpreted against the fact that Mozambique has a massive displaced population as a result of the protracted civil war. In 1992, some 1,5 million refugees were spread roughly as follows (Economist Intelligence Unit, 1996a:9); 1,1 million in Malawi, 150 000 in Zimbabwe, 20 000 in Tanzania, 25 000 in Zambia, 24 000 in Swaziland and at least 200 000 in South Africa. In addition to this, at least 4-5 million *deslocados,* or internally displaced refugees, existed within Mozambique. Seen against this risk profile, Mozambique thus has considerable potential to destabilise the study area in future by being the source of refugees that the other Southern African states will be forced to deal with. The prospect of an improvement in political stability in future reduces the risk somewhat, especially if the rebels can be disarmed. Given the magnitude of the problems caused by the protracted civil war however, Mozambique is likely to remain a source of potential regional instability. The HPRP is therefore high for the year 2025, but is low for the years 1982 and 2000. This provides strong evidence regarding the impact of population growth on water scarcity.

Subproblems 3 & 4: Agricultural and Industrial Sector

The contribution to GDP of each sector indicates the overall economic "mix" of the country. The following sectoral data is provided by the World Bank (1996:18-20) and is presented as a percentage of total real GDP for the year at constant 1987 US Dollar prices:

TABLE 37

SECTORAL CONTRIBUTION TO GDP FOR MOZAMBIQUE

YEAR	1987	1988	1989	1990	1991	1992	1993	1994
Agric	41%	40%	39%	39%	36%	32%	33%	33%
Ind	13%	13%	13%	12%	12%	12%	9%	8%

Mozambique is one of the poorest countries in the world (Europa, 1995:2146), with revenue from taxes covering only 45% of the public expenditure in 1994 (Africa Review, 1996:137), making the everyday running of the country dependent on international assistance. It was estimated that in 1994, Mozambique required US$ 1,429m in external funding, US$ 405m of which was in debt relief alone (Europa, 1996:650). The data set for both agriculture and industry shows a steady decline for both sectors. Future national self-sufficiency is thus likely to remain elusive for some time to come. A decrease in industrial contribution coincides with the ending of the war and a return to peace. While this cannot be fully explained with the data available, it is possibly linked to the fact that the industrial sector was on somewhat of a war footing during hostilities. This sector shows the effects of a reduction of state expenditure in general, and with it the multiplier effect caused by the movement of that money throughout the economy, as the war came to an end. In a 'virtual water' context, this implies that the capacity of the economy to finance food importation is severely restricted. Mozambique is likely to remain a subsistence-based economy as a result. Available land per capita is thus highly relevant in this case as a developmental constraint.

Sectoral Water Efficiency Ratio

Only two data sets are available for water consumption. Table 9 only shows agriculture for 1987 expressed as a percentage of total consumption. The World Bank (1996:379) gives sectoral consumption for 1995 expressed as a percentage. These are as follows:

TABLE 38

SECTORAL WATER CONSUMPTION FOR MOZAMBIQUE

	TABLE 9	WORLD BANK
	1987	1995
Agric	66%	89%
Ind	n/a	2%

The SWE can be derived from this by comparing sectoral water consumption (Table 38) with sectoral contribution to GDP (Table 37). This is as follows:

TABLE 39

SECTORAL WATER EFFICIENCY FOR MOZAMBIQUE

	1987	1995
Agric	66:41	89:33
Ind	? :13	2:8

There is a reasonable correlation between the contribution side of the two data sets for agriculture, and a fair correlation for industry. Consumption figures vary somewhat however. From this it is still evident that in the agricultural sector a high portion of the total water consumed (>50% in 1987 and >75% in 1995) produces a relatively smaller contribution to the GDP (25-50%). The agricultural SWE is medium for 1987 and low for 1995. Thus we have the situation where agriculture, which is known to have an extremely low 'return to water', is the dominant sector of the economy, and this comprising mostly of subsistence farming. The industrial SWE is low. Mozambique is thus clearly a "water inefficient" state, with little prospect of change evident in the future. There are even indications of a distinct worsening of the situation if foreign assistance is not forthcoming, given the magnitude of displaced people and degree of economic underdevelopment.

Political Factors: Lowi's Variables

Resource Need / Dependence

Mozambique has the fourth largest level of recoverable resources in the study area (Appendix "B") with access to 6 of the major river basins (Table 1). In order of magnitude these are the Zambezi, Shire, Luangwa, Lurio, Limpopo and Save. Given the projected WSI position of 23 by the year 2025, it will need to improve the level of technological inputs to an intermediate level. This will only be possible with a stronger economy. Mozambique is one of the poorest countries in the world however (Europa, 1995:2146) so this is unlikely to happen. While agricultural production capacity is considerable, loss of infrastructure and war displaced people are limiting factors. Landmines are an unresolved problem (Africa Review, 1996:137). Mozambique has the potential to export hydro-electricity, but it cannot currently satisfy its own needs (Economist Intelligence Unit, 1996d:23). The Cahora Bassa Dam was constructed in 1975 with a design capacity of 3 870 MW (Davies *et al.*, 1993:150). The generating capacity in 1982 was 2 075 MW. By 1983 South Africa was absorbing some 98% of the output, but because of the civil war the dam was only operating at 0,5% of its potential by 1987. Cahora Bassa has the potential to become the countries biggest source of foreign earnings estimated at US$ 56 million per year. An agreement in 1992 and subsequently in 1994 allows Zimbabwe to purchase 500 MW from Cahora Bassa (approximately 25% of the installed capacity) (Europa, 1996:653). There are plans to construct a US$ 2,0 billion aluminium smelter in Maputo (Van Pletsen, 1996:12). This will have the capacity to produce 500 000 tonnes of aluminium per annum and will create significant employment opportunities. Aluminium production is a major electricity consumer. There are also plans to construct a hydro-electricity generating plant at Mepanda Uncua with a capacity of 2 000 MW (Van Pletsen, 1996:4). This represents a significant improvement in the otherwise low SWE of Mozambique if the proposed projects are finalised.

Investor confidence is not high however, so funding for major projects is likely to remain problematic. The overall needs for reconstructing the war torn economy are vast. This means that there will be competition between water-related projects and other equally needy causes. There is significant potential for both agriculture and tourism, but these cannot be readily harnessed for three reasons. Firstly, existing legislation prohibits private ownership of land. Investors are thus reluctant to invest when they have no security of tenure. Secondly, infrastructure is a major shortcoming. To move crops to market or to move tourists to their destination is a problem. Thirdly, there are significant quantities of unexploded landmines throughout the country. This prevents the possible exploitation of land for either agriculture or tourism. Peasant farming is hazardous for this reason.

In terms of calculations by Vaclav Smil, less than 0,07 ha of land per person in a country renders that country incapable of feeding their own population, without intensive use of technological inputs. Mozambique will probably reach this critical threshold by the middle of the next century (Ohlsson, 1995a:34). Given the above, it can be concluded that although Mozambique has access to a number of rivers other than the Zambezi, and should thus not be totally reliant on the latter, this is not the case in reality. Electricity from Cahora Bassa is a vital generator of foreign earnings and in the absence of other economic developments, the resource need can be considered to be high in terms of the Zambezi Basin.

Rapport de Forces

Mozambique is in a low order riparian position on the Zambezi River as well as within the other river systems. This is traditionally a weak riparian position to be in. In the absence of any significant economic development, Mozambique is unable to be considered as a power in any sense of the word. In terms of traditional Realist thinking, Mozambique can be considered incapable of even administering itself and can therefore be seen as a 'power vacuum'. The military, such as it is, could only function as a proxy army during the Cold War. Post-Cold War capacity can thus be regarded as being negligible. As already demonstrated, it has considerable potential to destabilise the region by "exporting" migrants, which become a problem for other developing countries.

Mozambique is not actively involved in territorial or other forms of regional disputes. There have been traditionally good relations with Zimbabwe as a result of the experiences that were shared by both states during their respective liberation struggles.

A significant development project aimed at restoring the infrastructural access from Gauteng, in South Africa, to the harbour facility at Maputo, was recently launched as part of the post-apartheid reconstruction of South Africa (Maharaj, 1996). While this will only benefit the southernmost parts of Mozambique, it is noted that 52% of all economic activity in Mozambique is generated in the Maputo Province (Maputo Development Corridor, 1996:33). This may help create employment and generate the transferral of skills needed to rehabilitate Mozambique, at least to a limited extent. Significantly, Cahora Bassa electricity will be redirected from South Africa back down the corridor to Maputo (Maputo Development Corridor, 1996:28) given the current lack of infrastructure present.

Character of Riparian Relations

As already noted (see the analysis on Malawi), there have been strained relations with Malawi over allegations that Malawi harboured RENAMO rebels (Europa, 1995:1968). There are good relations with South Africa at present. There are historic links with Zimbabwe as noted previously.

The industrial sector has responded poorly to policy reform, with 1986 outputs shrinking to 44% of 1981 levels. By 1994 the industrial sector was roughly equivalent in size to its 1986 level (Economist Intelligence Unit, 1996d:15). Inflation is high, with a level of 50% recorded in 1994 (Africa Review, 1996:137). This implies that job creation is likely to remain a problem that can be regarded as a migrant push-factor. This will impact negatively on other states in the study area.

There is an unresolved, but dormant dispute with Malawi, over parts of the common border, which according to Malawi are on the Zambezi River and Indian Ocean. This is based on the ancient Maravi Empire (Day, 1987:156) as recorded by Portuguese navigators. Mozambique is not contesting this in any way.

Mozambique is a signatory to 5 of the 22 major agreements within SADC (Ohlsson, 1995a:59-60) other than the Protocol on Shared Watercourse Systems in the Southern African Development Community (SADC) Region. These are the LBPTC, PJCC, JPTWC, JPTC and SARCCUS (Appendix “E”).

Conclusion

Mozambique is a problem state for the study area given its economic under-development and lack of infrastructure. It could be argued that it has ceased to function as a state in the modern sense of the word. This poses a major burden on Southern African states to successfully support post-war reconstruction, failing which Mozambique is likely to become the epicentre of a series of outward refugee migrations. This is likely to be stimulated by push-factors, such as loss of access to resource flows, and pull-factors such as the perceived wealth in places like South Africa, Zimbabwe and Botswana. Decentralisation of industry is thus seen as a crucial part of a regional development strategy. Electric power generated from the Zambezi forms a cornerstone of this proposed strategy. The Zambezi as a resource is thus likely to remain one of the most significant factors in the rehabilitation of Mozambique.

Regarding the SWE for both the industrial and agricultural sectors, Mozambique can be regarded as having a low efficiency. This implies that limited benefit would be derived from a 'virtual water' based development strategy, as there is insufficient gearing in the economy to finance the 'virtual water' importation in a sustainable manner.

NAMIBIA

Subproblems 1 & 2: Water Scarcity and Population Growth

Recoverable Water Resources

The volume of recoverable water resources for Namibia is 9 km^3 / yr^{-1} (Table 4a and Appendix "B"). This means that Namibia has the lowest level of recoverable water resources in the study area, a position that is shared with Malawi and Botswana.

Population Growth

The population growth figures for Namibia are as follows (Table 6 and Appendix "B"):

TABLE 40

POPULATION GROWTH FOR NAMIBIA

YEAR	MILLIONS
1982	1,07
2000	2,38
2025	4,29

Water Barrier Scale

From the above data, the number of persons / 'flow unit' for Namibia can be calculated as follows (Table 4a and Appendix "B"):

TABLE 41

PERSONS / 'FLOW UNIT' FOR NAMIBIA

1982	2000	2025
120	260	480

Hydrological / Population Risk Assessment

When these data are tested against the norm provided for by the WBS as presented in Appendix "D", it can be seen that Namibia has a moderate level of water competition within its own borders. This corresponds to Position 2 (Mid European Conditions) for 1982, 2000 and 2025. The relative impact of a lower population base on resource competition is evident. In this case Namibia is considerably better off than Malawi, and only slightly worse off than Botswana, with all three countries having the identical amount of recoverable surface water resources. A significant point to note, particularly with regard to Namibia, is the spatial distribution of people. Given the large physical size of Namibia, coupled with the relatively low population level, it means that there are concentrations of people around specific centres. Traditionally these are around Windhoek and in Owamboland. This in turn means that given the arid nature of the climate, water has to be moved vast distances to where it is needed. This in turn means that while the WSI statistics reveal a low competition level in general, there can be a high level of competition in these areas of greater population density. When these

WBS data are tested against Falkenmark's WSI Matrix presented in Appendix "D", the following data can be derived:

TABLE 42

WSI FOR NAMIBIA

1982	2000	2025
22	32	32

Namibia is in a current position where mainly quality and dry season problems exist, with intermediate levels of technological inputs being sufficient. The ENWC, a series of pipelines and canals, more than 750-km long, that will ultimately abstract water from the Kavango River (Ohlsson, 1995a:53); and the Ruacana-Ondangwa pipeline, are evidence of this (Figure 16). Namibia is moving into a position where quality and dry season problems are to be expected, with high levels of technological inputs being required to maintain self-sufficiency in future. This is potentially problematic. In this regard it is noted that Namibia has a relatively small population, but will need high levels of technological inputs, which in turn will have to be financed. The small population implies a small tax base, which in turn implies a limited ability to finance the increasing levels of technology needed. In Namibia, this is particularly true, given the large physical size of the country as noted above. In crude terms this means that the number of taxpayers per kilometre of pipeline is low and therefore the burden per individual is high. Economic viability and sustainability thus become a major concern in Namibia. The HPRP is thus medium for the year 1982 and high for the years 2000 and 2025.

Subproblems 3 & 4: Agricultural and Industrial Sector

The contribution to GDP of each sector indicates the overall economic "mix" of the country. The following sectoral data is provided by the World Bank (1996:18-20) and is presented as a percentage of total real GDP for the year at constant 1987 US Dollar prices:

TABLE 43

SECTORAL CONTRIBUTION TO GDP FOR NAMIBIA

YEAR	1987	1988	1989	1990	1991	1992	1993	1994
Agric	12%	14%	13%	13%	13%	11%	13%	14%
Ind	30%	30%	28%	27%	27%	30%	25%	26%

Mining contributed 17% towards GDP in 1993 (Europa, 1995:2177) indicating that this is a dominant sector within Namibia. It must be noted that mining is calculated as part of the industrial sectoral contribution. Manufacturing is thus relatively small. Namibia is in a unique position however, in that it had all of its foreign debt to South Africa written off (Europa, 1995:2177) when the first post-apartheid democratic government was elected in that country. This has benefited Namibia considerably with a manageable inflation rate as a result. This makes development prospects good for the future. There has been a reasonably constant contribution by each sector. The implications for a 'virtual water' strategy are that a leverage effect is possible.

Sectoral Water Efficiency Ratio

Only two data sets are available for water consumption. Table 9 only shows agriculture for 1987 expressed as a percentage of total consumption. The World Bank (1996:379) gives sectoral consumption for 1995 expressed as a percentage. These are as follows:

TABLE 44

SECTORAL WATER CONSUMPTION FOR NAMIBIA

	TABLE 9	WORLD BANK
	1987	1995
Agric	82%	68%
Ind	n/a	3%

From this the SWE can be derived by comparing sectoral water consumption (Table 44) with sectoral contribution to GDP (Table 43). This is as follows:

TABLE 45

SECTORAL WATER EFFICIENCY FOR NAMIBIA

	1987	1995
Agric	82:12	68:14
Ind	? :33	3:26

There is a good correlation between the contribution side of the two data sets for agriculture, and a reasonable correlation for industry. Consumption figures vary somewhat however. From this it is still evident that in the agricultural sector a relatively high portion of the total water consumed (>75% in 1987 and >50% in 1995) produces a relatively smaller contribution to the GDP (<25%). Agriculture does not dominate the economy, a factor that is reflected in the SWE data. Namibia thus has a low agricultural SWE for 1987 and a medium SWE for 1995. The industrial SWE is medium for both years.

Political Factors: Lowi's Variables

Resource Need / Dependence

Namibia has the lowest level of recoverable water resources in the study area (along with Botswana and Malawi). It has access to 4 of the major river basins in the region (Table 1). In order of magnitude these are the Zambezi, Orange, Kavango and Cunene. There are no perennial rivers within the country (Arnestrand *et al.,* 1993:51) with the major surface water found on the borders of the state, mostly in the north. This makes Namibia rather unique, given the spatial distribution of population previously noted. When combined with the large physical size of the state, the logistical problems become significant.

Development of the Cunene, one of the smallest rivers in the region in terms of volume (3,3% of the size of the Zambezi), is vulnerable as Angola controls the headwaters. Angola has 4 major dams on the Cunene, three built primarily for hydropower generation. Power from the Matala and Ruacaná amounts to 280 MW and is used by both Angola and Namibia. The Calueque Dam was abandoned during the war, and the Gove Dam was damaged. This has put irrigation schemes in Angola out of order, and the resultant loss of flow regulation has reduced Ruacaná to a run of the river hydroelectric generating capacity. Epupa Dam would become the third largest dam in

Southern Africa (Conley, 1996c:35-6) if built. It is anticipated that one of the last of Africa's truly indigenous populations, the Himbas, will be adversely affected by the Epupa project (Ohlsson, 1995a:54). In addition to this, several rare species of fish risk extinction. The project may not proceed due to the actions of international environmental pressure groups. Rehabilitation of the dams destroyed in Angola will increase irrigation yield in that country and thus reduce the flow available to Namibia.

The Kavango is 3,7% the size of the Zambezi. Development of the Kavango has resulted in the completion of a 302-km long canal from Omatako to Grootfontein. The final phase involves connecting this canal to the Kavango River. It may be extended to the Zambezi River in future (Ngipandulwa, 1996). The volume of water which is intended for abstraction is 4 cumec (Ohlsson, 1995a:54). This has caused considerable concern to Botswana, as the environmental impact assessment had been limited to the Namibian side of the border. Parkman Water Transfer Consultants have since been engaged and the terms of reference have been changed to the satisfaction of Botswana.

Recent political developments in Angola suggest that attention is being drawn to the agricultural and industrial development in the climatically favourable upper Kavango basin. This could affect the quality of water entering the Okavango Delta (Arnestrand *et al.*, 1993:29). The Omatako Canal forms part of the ENWC in Namibia and is controversial from an ecological viewpoint. The overall IBT involves several rivers (Swakop, Omatako, Kavango) through which the water is channelled, a borehole scheme for harvesting groundwater, several storage dams and the open Grootfontein-Omatako Canal (Davies *et al.*, 1993:167). The Omatako Canal has been called a "death trap for wild animals" that drown while trying to cross; a situation that has necessitated the patrolling of the scheme (Ohlsson, 1995a:53-4). This is one of the most emotive aspects of the project. The evaporative water losses are in the order of 70% (Davies *et al.*, 1993:168) so the long-term sustainability is questionable. The ultimate plan is to link Rundu with Windhoek (Conley, 1996c:43). The following schematic representation of the ENWC shows how the Okavango Delta fits into the overall water strategy of Namibia, indicating the complexity of the overall design.

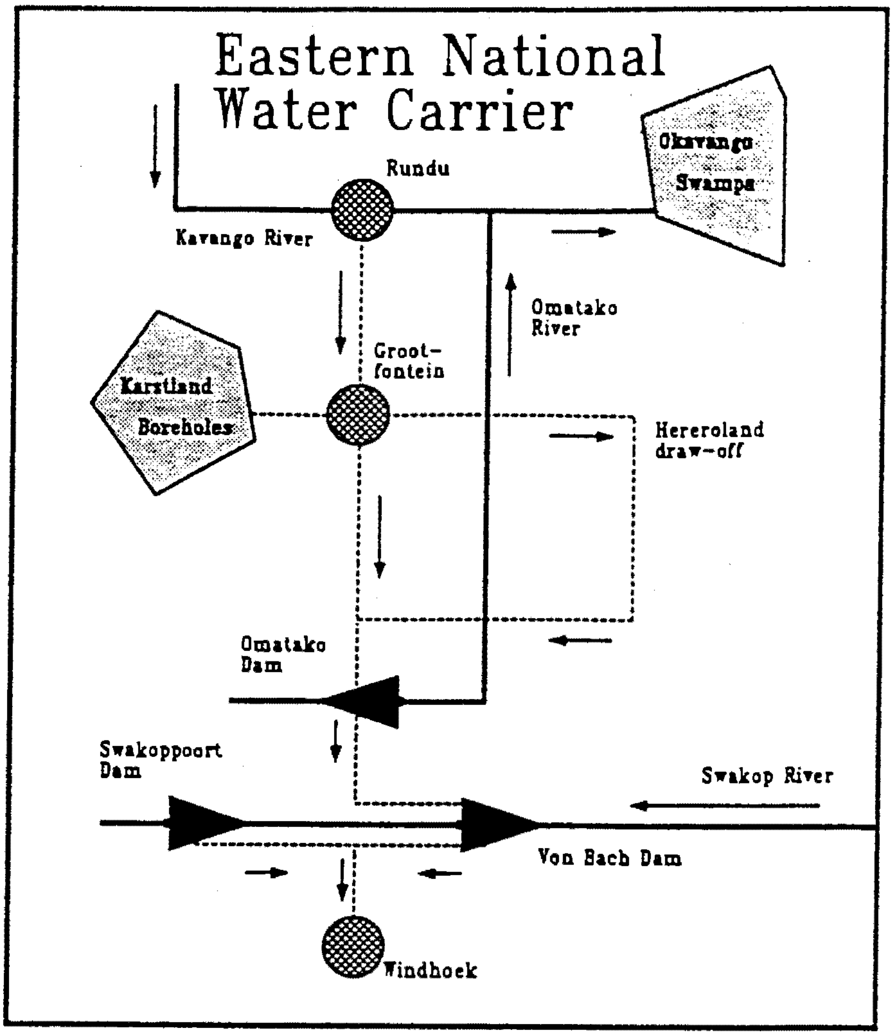


Figure 16. Schematic Layout of the Namibian ENWC (Davies *et al.*, 1993:167).

The Orange River poses somewhat of a unique situation. At the time of independence, Namibia was not the legal riparian of this river, with the international border being on the Namibian bank. South Africa thus had sovereignty of both banks and with this came the absolute right of control (Du Pisani, undated). Since independence this has changed (along with sovereignty of Walvis Bay). In 1987 the former interim government and South Africa signed an agreement on the use of the water from the Orange River (Europa, 1996:676). Full sovereignty was later conceded. The Orange River Basin is highly developed. Diffuse and point source pollution in the industrialised Gauteng heartland has raised salinity in the middle and lower reaches (Conley, 1996c:31). Eutrophication is also a problem. The value of the resource to Namibia is thus limited by these factors, which are typical of the problems experienced by a downstream riparian in any developed basin. The Orange River in total capacity is only 5,6% that of the Zambezi and only a limited portion is left for Namibian use.

The Zambezi is thus the only remaining surface water of significance left for Namibia to develop. The resource need for Namibia from the Zambezi is thus vitally important, especially given the high WSI (32 by the year 2000) and resultant high level of technological input needed for self-sufficiency. From an engineering viewpoint, Grootfontein can be supplied from an abstraction point on the Zambezi upstream of Victoria Falls. This same abstraction point could feed Francistown in Botswana, Bulawayo in Zimbabwe and Gauteng in South Africa (Alexander, 1996) making this is a complex political issue, but one that is likely to attract the support of these other states due to the coincidence of national interest.

As further evidence of the extreme nature of the resource need, there are plans to develop a desalination plant at Walvis Bay (Van Pletsen, 1996:12). This is traditionally an extremely expensive technology, and not usually viable unless it can be linked with access to cheap hydrocarbons. Even Saudi Arabia, a major user of this technology, only generates a small proportion of the total water needs in this manner, mostly by using excess hydrocarbons. The long-term viability is thus questionable.

Rapport de Forces

Given the fact that post-war reconstruction in Angola is going to increase the demand from that state on the waters of the Cunene and Kavango, mostly for irrigation purposes, Namibia is in a relatively weaker position. Access to the Zambezi is via the narrow Caprivi Strip which is environmentally sensitive and thus under scrutiny from international environmentalist groupings. In the south, the waters from the Orange are of reduced quality and far from major development centres. Thus on all four river basins, Namibia is a low order riparian and therefore in a weak position.

On the positive side, Namibia is one of the most peaceful countries in Africa (Africa Review, 1996:141), and given the low foreign debt burden, is relatively creditworthy in terms of international financial institutions. These positive features could make Namibia more attractive as a political ally when it comes to raising the credit guarantees needed for such large IBTs that are likely to be needed by certain states in the study area. The economic conditions, while being reasonably healthy, are primarily of an extractive nature with the overall economy being poorly integrated (Europa, 1996:673). The military capacity is limited, but was increased in response to the Kasikili-Sedudu dispute (the reader is referred to a detailed case study in Chapter 4). Sustained hostility could thus probably not be maintained in the event of a resource dispute escalating to armed conflict. When compared to the Botswana military capacity, Namibia is definitely the weaker of the two. There are perceptions within the decision-making echelons of the Namibian government that Botswana is arming itself for a possible future resource-based conflict (Webster, 1996). Namibia is likely to remain dependent on South Africa for a long time to come (Europa, 1996:676), so independent action by Namibia in issue-areas that adversely affect South Africa is unlikely.

Character of Riparian Relations

In March 1993 UNITA alleged that members of the Namibian Defence Force (NDF) crossed into southern Angola to assist government forces in an offensive against UNITA. It was later alleged that 2 000 Cuban troops had landed in Lüderitz, from where they were transported to assist the Angolan government forces against UNITA. A 550-km stretch of border between Angola and Namibia was closed from September 1994, following an attack attributed by the Namibian authorities to UNITA, as a result of which three Namibians were killed (Europa, 1995:2176).

There are good relations with post-apartheid South Africa. Full sovereignty over Walvis Bay was conceded to Namibia in 1994 (Europa, 1995:2176) and Namibia benefited from the debt cancellation by South Africa (Europa, 1995:2177). Plans were developed in 1994 for the linking of Botswana to the port facility at Walvis Bay (Europa, 1995:605). Plans are now in an advanced stage of extending the Maputo Corridor via Botswana (Finansies & Tegniek, 19/9/97). This will be known as the Trans-Kalahari corridor and will impact favourably on the economic development of Namibia. Despite the fact that there has been armed confrontation over the Kasikili-Sedudu Island which has resulted in an exchange of fire, relations between Namibia and Botswana remain good. This is dealt with in detail in Chapter 4 as a case study. Namibia wishes to maintain a peaceful coexistence with its neighbours (Webster, 1996).

Of the 22 major agreements that exist between SADC states involving water, Namibia is a signatory to 8 (Ohlsson, 1995a:59-60) in addition to the Protocol on Shared Watercourse Systems in the Southern African Development Community (SADC) Region. These are the ANJCC, PJTC, JCA, OKACOM, JPWC, Permanent Water Commission (Orange), JIA and SARCCUS (Appendix "E").

Efforts at Conflict Resolution

Following the failure of a mediation attempt by President Robert Mugabe of Zimbabwe, Namibia and Botswana referred the Kasikili-Sedudu Island dispute to the International Court of Justice for adjudication (Europa, 1995:2176). There is thus limited evidence of the existence of a culture of peaceful conflict resolution.

Conclusion

Namibia is in a weak and vulnerable position when seen in overall regional hydropolitical terms. It has a unique set of circumstances resulting from a combination of aridity, a lack of running rivers within the borders, relatively sparse population and large physical size. It is a low order riparian state with a relatively weak, if generally healthy economy. Access to water is both spatially and temporally limited, with all reliable surface water originating from outside its borders. Namibia does have a role to play as a useful ally and brings into such a relationship a fairly healthy but limited creditworthiness. On analysis this is its main political asset. It is doubtful whether Namibia could act independently, and it falls heavily within the South African sphere of influence.

Regarding both the agricultural and industrial SWE, Namibia can be regarded as having a medium level of efficiency. This implies that there would be advantages to be derived from the adoption of a 'virtual water' based development strategy as there is a degree of gearing present within the economy. This can be enhanced by the adoption of the free trade area around Walvis Bay, which is likely to generate more economic growth and the integration of the economy by means of the Trans-Kalahari corridor. Namibia's one advantage is the relatively small population it has, as this implies that even limited economic growth can benefit the country.

SOUTH AFRICA

Subproblems 1 & 2: Water Scarcity and Population Growth

Recoverable Water Resources

The volume of recoverable water resources for South Africa is 50 km^3 / yr^{-1} (Table 4b and Appendix "B"). The World Bank (1996:379) gives an identical figure. This means that South Africa has the third lowest level of recoverable water resources in the study area, but approximately one third of what Angola has and about half of what Zambia has.

Population Growth

The population growth figures for South Africa are as follows (Table 6 and Appendix "B"):

TABLE 46

POPULATION GROWTH FOR SOUTH AFRICA

YEAR	MILLIONS
1990	35,2
2025	63,2

Water Barrier Scale

From the above data, the number of persons / 'flow unit' for South Africa can be calculated as follows (Table 4b and Appendix "B"):

TABLE 47

PERSONS / 'FLOW UNIT' FOR SOUTH AFRICA

1990	2025
741	1 419

Hydrological / Population Risk Assessment

When these data are tested against the norm provided for by the WBS as presented in Appendix "D", it can be seen that South Africa has a high level of water competition within its own borders already. This corresponds to Position 3 (Water Stressed Conditions) for 1990 and Position 4 (Chronic Scarcity Conditions) by 2025. This is recognised in the White Paper on Water Policy (DWAF, 1997:2.2.2; 3.1).

These figures fail to cater for the impact of a potential refugee influx. They also fail to show the impact caused by the fact that large populations are concentrated around industrial areas. Therefore, like Namibia, there is a vast difference in the spatial distribution of the population. Unlike Namibia however, the larger population in South Africa implies a bigger tax base and therefore more financial resources that can be applied to the water distribution problems. These factors should be considered when making the hydrological / population risk assessment for South Africa. The White Paper on Water Policy recognises the need for IBTs to distribute water spatially (DWAF, 1997:6.6.1). When these WBS data are tested against Falkenmark's WSI Matrix presented in Appendix "D", the following data can be derived:

TABLE 48

WSI FOR SOUTH AFRICA

1990	2025
33	34/44

In terms of the WSI, South Africa is in a current position where a food and water crisis exists, with high levels of technological inputs being needed to maintain self-sufficiency. As evidence for this, of the 22 major agreements that exist between SADC states involving water, South Africa is a signatory to 9 (Ohlsson 1995a:59-60). The LHWP is one of these international agreements and it is currently the largest project of its kind on the African continent (Davies *et al.*, 1993:143). Even with the LHWP, shortages are anticipated in the first quarter of the next century, so a larger project, the Zambezi Aqueduct, is being planned. This involves the abstraction of water from the Zambezi River at Kazungula, and transferring it via a 1 200 km long set of pipelines and canals through Botswana to Gauteng (Ohlsson, 1995a:54). The HPRP is regarded as being very high.

Subproblems 3 & 4: Agricultural and Industrial Sector

The contribution to GDP of each sector indicates the overall economic "mix" of the country. The following sectoral data is provided by the World Bank (1996:18-20) and is presented as a percentage of total real GDP for the year at constant 1987 US Dollar prices.

TABLE 49

SECTORAL CONTRIBUTION TO GDP FOR SOUTH AFRICA

YEAR	1980	1988	1989	1990	1991	1992	1993	1994
Agric	6%	6%	6%	6%	6%	5%	5%	6%
Ind	45%	41%	40%	31%	30%	30%	30%	30%

Despite South Africa's mineral wealth and highly developed manufacturing sector, economic progress was hindered due to the imposition of economic sanctions (Europa, 1995:2771) in response to the policy of apartheid, the effects of which are still being felt in the post-apartheid era. Economic sanctions became a significant factor in 1986 after President P.W. Botha's Rubicon speech. The effects of this are not immediately apparent in the data set due to the reasonably sound economic position that South Africa was in at the time. The effect of sanctions was to cut off access to foreign funding. This implied that there was a lag-time between the imposition of sanctions and their effects being reflected in the economy. Part of this lag-time was the result of the reasonably sound gold price that prevailed at the time.

After the Rubicon speech, there was a relatively calm period in political terms. The reason for this was a significant allocation of state resources to the security forces. The political calm was thus largely artificially induced, and is attributed by some to massive repression. The late 1980s were also a period of substantial drought, which meant that food had to be imported (in keeping with the 'virtual water' approach). Significantly, the burden of paying foreign currency for these purchases, coupled with the scarcity of foreign currency that sanctions had induced, meant a gradual decline of the contribution by industry as the economy generally slowed down. The interesting aspect of this analysis, is that it shows what can happen in a 'virtual water' scenario if the industrial sector is not contributing adequately. Caution is called for in drawing too drastic a conclusion however, as the situation in South Africa during the sanctions period was artificial, and the data set is really too limited.

When the first post-apartheid democratic government was elected, Namibia had all of its foreign debt to South Africa written off (Europa, 1995:2177). High expectations exist regarding the capacity that South Africa has as the engine of growth in the study area. It is the most diversified economy in the study area and thus has a key role to play. The main factor that governs South African relations with other states in the study area, except for Angola and Tanzania, is their economic dependence on the overwhelmingly stronger South African economy (Barratt *et al.*, 1994:21).

Sectoral Water Efficiency Ratio

Only two data sets are available for water consumption. Table 9 does not show South African statistics, but Table 10 gives a detailed breakdown for 1980 and 1990. The World Bank (1996:379) gives sectoral consumption for 1995 expressed as a percentage. There is a good correlation for these two data sets regarding industry, but there is some variance regarding agriculture. Table 10 originates from the South African Department of Water Affairs. These are as follows:

TABLE 50

SECTORAL WATER CONSUMPTION FOR SOUTH AFRICA

	TABLE 10		WORLD BANK
	1980	1990	1995
Agric	54%	52%	72%
Ind	11%	13%	11%

The data from the World Bank shows a higher level of sectoral water consumption for agriculture. The possible explanation for this could be the fact that the South African derived figures in Table 10 reflect a bias in favour of the farmer. Prior to democratisation, the ruling party had white commercial farmers as a major element of its constituency. This fact, coupled with the apartheid induced belief that South Africa should be agriculturally self-sufficient in the face of sanctions, meant that there was a vested interest not to report the true state of affairs. This is particularly true when one considers that the black majority in South Africa was largely denied access to clean water under apartheid rule. This makes the bias politically embarrassing if it is shown that the white farmers largely squandered their water allocation on inefficient agricultural practices, while the black majority was denied basic access to potable water. This is in keeping with the point previously made about the paucity of accurate data. Unfortunately this impacts on the subsequent analysis. The truth about the data will never be known, as there is such a paucity of it that no hard and fast conclusion can be drawn. In keeping with scientific objectivity, both data sets are left for the reader to appraise. The reader is thus cautioned in this regard.

From this the SWE can be derived by comparing sectoral water consumption (Table 50) with sectoral contribution to GDP (Table 49). This is as follows:

TABLE 51

SECTORAL WATER EFFICIENCY FOR SOUTH AFRICA

	1980	1990	1995
Agric	54:6	52:6	72:6
Ind	11:45	13:31	11:30

There is a good correlation between the contribution side of the three data sets for agriculture, but there is some variance for industry. Consumption figures correlate for industry, but there is a variance for agriculture. From this it is still evident that in the agricultural sector a relatively high portion of the total water consumed (>50% in 1980 and 1990) produces a small contribution to the GDP (<10%). This is regarded as medium efficiency. Conversely the small volume of water consumed for industry (around 10%) contributes a large portion of the GDP (around 30%). This is regarded as medium efficiency. The White Paper on Water Policy recognises the sectoral water efficiencies as an underlying principle (DWAF, 1997:2.1.8; 4.2.1; 5.1.2). The potential bias in the agricultural consumption figures impact on this by showing a more favourable situation than actually exists, so this conclusion is drawn tentatively only. The improvement that is needed is likely to entail a reduction in the irrigation of low value grain crops in favour of either crops which yield a higher 'return to water', or to industry which probably yields the highest return possible. The re-allocation of water away from agriculture is likely to further alienate the largely white farming community in South Africa, resulting in hydropolitical tensions of its own. This is beyond the scope of the current study. The political priority of water is recognised in the White Paper on Water Policy (DWAF, 1997:2.2.1).

<u>Political Factors: Lowi's Variables</u>

Resource Need / Dependence

South Africa has the third lowest level of recoverable resources available in the study area. This is coupled with the highest total population in the study area (Appendix "B"). South Africa has access to 2 of the major river basins of the study area (Table 1). In order of magnitude these are the Orange and Limpopo. South Africa is not a riparian of the Zambezi River and thus has no legal claim to the waters of that river. The Orange River is highly utilised with limited opportunity for additional future development (Conley, 1996c:28). The Limpopo River is close to being fully committed by the upstream riparians (Conley, 1996c:35) making significant future abstraction potentially unsustainable. Eutrophication is also a problem.

South Africa is characterised by a large number of regulating structures (dams) to meet the water needs of the state. There are at least 500 "major" regulating structures that capture 50% of the MAR, which in turn is < 9% of the MAP. All of the large and medium size rivers have been impounded, often as a cascading series of dams (Davies *et al.*, 1993:137). The most significant river is the Vaal/Orange. The LHWP is the largest IBT in Africa, and when this is in operation 75% of the water of the Vaal River will be imported from other catchments. IBTs will harness almost 9% of the total MAR and as such will become increasingly important as a tool for supplying water to South Africa. The White Paper on Water Policy recognises that IBTs are needed to ensure economic growth (DWAF, 1997:6.6.1) by redistributing water spatially within the country. There are currently 11 IBTs in operation (Davies *et al.*, 1993:143). These are the Tugela-Vaal Scheme, Orange River Project, Usutu Scheme, Komati Scheme, Usutu-Vaal Scheme, Riviersonderend-Berg River Scheme, Palmiet River Scheme, Amatole Scheme, Mzimkulu-Mkomaas-Illovo Scheme, Lesotho Highlands Water Transfer Scheme and Mooi-Mgeni Scheme. The Zambezi Aqueduct is being mooted to bring water from the Zambezi River via Botswana, as almost all of the locally available surplus water has been committed. This will later be extended to transfer water from the Zaire (Congo) Basin via the Lualaba-Zambezi IBT (Africa Analysis, 26/7/96:14).

Given the fact that South Africa has the largest population in the study area (Table 6 and Appendix "B") there is great pressure on the water resources. As evidence of this, South Africa has the highest set of derived WSI data for the region (between 34 and 44 by the year 2025) (Table 7 and Appendix "B"). These imply a very high level of technological input needed to maintain self-sufficiency. This also suggests that water access is likely to increase the security vulnerability of South Africa in future.

The international isolation of South Africa that resulted from the policy of apartheid, created a prevailing political culture amongst the ruling elite that was based on the concept of national self-sufficiency. This resulted in projects such as the fuel from coal plant at SASOL and the development of the small gas field at Mossel Bay amongst others. The issue of long-term sustainability, environmental degradation and economic viability were thus seen to be of secondary importance when weighed against the prevailing belief that national survival was at stake. The perceptions of the decision-maker were thus reflected in policy. This was unfortunately true of agriculture, and possibly also regarding the electricity generation capacity of ESCOM that is largely coal based. Conley (1996c:19) notes that,

> "South Africa at present represents an example of a country which has reached a stage of its development where its scarce water resources will have to be allocated increasingly to the most worthwhile purposes only. ... South Africa's returns on agricultural production per unit of water give comparatively low returns for high consumption. While South Africa has neither the weather nor the soil to make it an ideal country for agricultural expansion, some of the more northern countries have sufficient water and land and would welcome additional economic opportunities. ... Being freed from the need for agricultural self-sufficiency which its period of isolation imposed, it would make economic sense for South Africa to satisfy its increasing needs for agricultural products from the open market, while employing its water to better advantage".

It can thus be said that South Africa has a critical dependence on water resources in general, and that in the absence of other viable alternatives, the Zambezi becomes the only exploitable reserve available. Unfortunately, South Africa is not a Zambezi riparian state and thus has no legal claim to this resource. Access will therefore have to be negotiated for, elevating the water issue as a potential area of 'high politics' for South Africa, as state survival will increasingly become linked to this one aspect in the future.

Rapport de Forces

Of the shared river basins in the region, South Africa is a high order riparian in the case of the Limpopo and the Orange. This is traditionally a stronger position in hydropolitical terms. Regarding the Zambezi River the situation is somewhat different. In this case South Africa has no direct access. Negotiated access is thus the only viable option, with this placing South Africa in a very low order, weak riparian position in the case of the Zambezi.

South Africa is the largest economy in the study area, with a total GNP in the early 1990s some 14 times bigger than the nearest rival, Zimbabwe. South Africa is also the most diversified economy in the study area. Due to the policy of apartheid, South Africa was systematically isolated. In 1980, SADCC (Southern African Development Co-ordination Conference) was established by the so-called 'front line states' to work towards a reduction of their economic dependence on South Africa. There is a history of armed incursions by South African forces in almost every Southern African State during the 1980s. As a result of political reform in South Africa, SADCC reformed itself to become SADC (Southern African Development Community) in 1992. SADC aimed to achieve closer economic integration of the region (Europa, 1994:2682). South Africa became a member of SADC as a result of the transition to a non-racial democracy. South Africa is committed to greater integration within SADC as part of the Growth, Employment and Redistribution (GEAR) macroeconomic strategy. This is recognised in the White Paper on Water Policy (DWAF, 1997:2.2.4).

South Africa has a history of belligerence and destabilisation during the years of apartheid. One such act of belligerence has been linked to water scarcity in the literature. Homer-Dixon (1994:19) suggests that the desire for access to water was an ulterior motive behind South African support for the 1986 Lesotho *coup d'etat.* Evidence cited is the fact that after thirty years of fruitless negotiation with Lesotho to divert water to the Gauteng region, shortly after the *coup d'etat* the two governments reached agreement on the LHWP. Evans (1997) refutes this evidence as being,

> "rather tenuous, ... as it was perfectly feasible for South Africa to abstract the water from the Orange River below Lesotho and transfer it to the (Gauteng) region. ... this alternative had its supporters in South Africa as, although it was more expensive, it would have left South Africa in sole control".

The direct link between water scarcity and belligerence has thus not been clearly established in this specific case beyond the tenuous conclusion drawn by Homer-Dixon (1994:19). This needs additional research.

Under the leadership of President Mandela, South Africa has pursued an independent and sometime controversial foreign policy, tending to favour those states that leant support to the African National Congress (ANC) during the anti-apartheid struggle (Europa, 1996:2892). This independent line suggests that South Africa will play a major role within Southern Africa. To this end it is significant that the first protocol in SADC which has reached finality is that concerning water (Protocol on Shared Watercourse Systems in the Southern African Development Community (SADC) Region)(Conley, 1996c:57).

It is argued that this is in keeping with the findings of Lowi (1990:386) that,

> "co-operation is not achieved unless the dominant power in the basin accepts it, or has been induced to do so by an external power. Moreover, the

> hegemon will take the lead in establishing a regime or accept a regime change, and will enforce compliance to the regime, only if it serves to gain as a result".

This Protocol can thus become a legitimising instrument in the hands of South Africa, and may thus not lead to a broader 'spill-over' and 'enmeshment' in Functionalist or Neo-Functionalist co-operative terms within SADC, unless this benefits the hegemonic power. Additional credence was given to this notion when Minister Kader Asmal announced on 15 July 1997 that South Africa was to sign a UN agreement on international resource utilisation (Cook, 1997). Minister Asmal also said that South Africa was prepared to co-operate with countries in the Nile Basin regarding policy development. Significantly while making the announcement, Minister Asmal said that,

> "one of the critical issues the (UN) convention seeks to address is the equitable sharing of international natural resources without causing harm to downstream neighbours".

Character of Riparian Relations

South Africa has had a history of belligerence during the period of apartheid. This was characterised by both military confrontation with neighbouring states, and the use of the inherent economic dependence of these states on South Africa to gain political advantage. This tactic has changed fundamentally in the post-apartheid era. South Africa has de-escalated the military conflict in the study area. Evidence of this can be found in the peace processes currently underway in Angola and Mozambique. Significantly the reward for the democratisation of South Africa has meant inclusion in the political structures of the region. This implies that South Africa's economic power, can now be transformed into political power, with considerable influence within the Southern African region. One of the examples of this has been the role that South Africa played in mediating within Lesotho on behalf of the OAU. In terms of Principle 11 of the White Paper on Water Policy, South Africa is committed to co-operation in a shared river basin in a way that respects the needs of downstream riparians (DWAF, 1997:2.2.5). In fact international obligations are afforded a high status, ranked in order of priority after the basic needs of South African citizens and the water needed to sustain the environment (DWAF, 1997:5.2.3; 6.2.2; 6.2.3); and before other internal demands such as for industry or agriculture.

South Africa has rewarded Namibia by writing off the debt of that state. This fact, along with the inherent relationship of economic dependence, means that Namibia is unlikely to follow an independent foreign policy that may be detrimental to South

Africa. The same holds true with Mozambique that will have a high dependence on South Africa for post-war reconstruction. Both Zimbabwe and Botswana present different cases however. These two states are stronger economically, and can thus afford to adopt a more independent foreign policy. Zimbabwe is "afraid that the reforms in South Africa now make (it) a more attractive place for western investment than Zimbabwe" (Africa Review, 1996:228). This implies that tensions between the two may increase, with the issue of water becoming a significant source of potential conflict given the high dependence of both states on this resource. This problem can be exacerbated if South Africa manages to negotiate access to the waters of the Zambezi Basin, as it would make Zimbabwe a lower order riparian than South Africa in that configuration, and reduce the flow available to Zimbabwe, at least until the Lualaba-Zambezi IBT can be implemented. There are also trade tensions between South Africa and Zimbabwe. This is particularly manifest in the textile industry. President Mugabe had a disagreement with President Mandela in September 1997 on the establishment of a summit for the SADC Organ on Politics, Defence and Security (Sunday Independent, 14/9/97). This organ is responsible for regional security, so if this dispute continues, it could further affect the relationship between South Africa and Zimbabwe.

The relationship with Botswana is good, but the militarisation of that state is a potential source of future conflict. This is likely to be exacerbated by the fact that the independent foreign policy line that South Africa takes is not always popular with the USA (Europa, 1996:2892). It is therefore significant that the Botswana military build-up is linked to American funding. In this regard it is noted (Rakabane, 1997) that the building of Botswana airbases are ascribed to American initiatives, with the latter being concerned about the ANC connection with the South African Communist Party (SACP) and their favouring of states like Cuba, Libya and Iran. In strictly hydropolitical terms, South Africa may therefore wish to decrease the potential importance of Botswana. The best way of achieving this foreign policy goal is to limit the degree of dependence on water from the Zambezi Aqueduct, by maximising the advantage of 'virtual water' and consequently by reducing the volume of water that needs to be transferred via the IBT. This is being realised already, as the White Paper on Water Policy is based on the fundamental principles of 'virtual water'. These are the SWE (DWAF, 1997:2.2.1), importation of water intensive products (DWAF, 1997:6.6.2) and the inherent win-win approach to co-operation with other basin states that is embraced in Principle 11.

Of the 22 major agreements that exist between SADC states involving water, South Africa is a signatory to 9 (Ohlsson, 1995a:59-60) in addition to the Protocol on Shared

Watercourse Systems in the Southern African Development Community (SADC) Region. These are the LBPTC, JPTC, JPTC, TCTA, JPTC, Permanent Water Commission (Orange), JIA, KOBWA and SARCCUS (Appendix "E"). The White Paper on Water Policy recognises the importance of the JPTC, LBPTC, KOBWA and LHDA (DWAF, 1997:6.9.1).

Conclusion

In South Africa, the potential benefit of 'virtual water' is significant, given the fact that the economy is the most diversified and developed in the study area, coupled to the fact that resource need is very high. Given the level of economic development, South Africa is likely to provide the major 'pull-factor' stimulus for regional population migration, and as such can become the prime destination for economic refugees in future. South Africa has the capacity in both economic and military terms to be called the regional hegemonic power, although in official circles this is actively downplayed. It also has a significant dependence on the resources of the Zambezi River for future national survival as one possible future strategic option available. Water can therefore become an area of 'high politics' for South Africa.

It is thus concluded that South Africa is likely to play the role within the Southern African region that Lowi (1990:386) suggests to be the appropriate one for a hegemon to play under these conditions, namely that of the establishment and enforcement of a new set of rules. The Protocol on Shared Watercourse Systems in the Southern African Development Community (SADC) Region was accepted by SADC shortly before South Africa became a member (DWAF, 1997:6.9.1), and it is this instrument that is likely to be used to guarantee access to the waters of the Zambezi River if needed. This is being reinforced by the signature by South Africa of the UN agreement on shared resources. The White Paper on Water Policy actually states that South Africa will actively support the development of a system of International Law to guide the management of shared river systems (DWAF, 1997:6.9.2) in support of this. South Africa needs to negotiate access to the waters of the Zambezi River, as it is not a riparian state. In this process, political influence will have to be exerted on states such as Namibia and Mozambique, in order to gain their support within SADC. Zimbabwe is likely to be antagonistic to this, with Botswana emerging within the *rapport de forces* dynamics as a major "balancer" of regional hydropolitical power in this scenario. To this end, considerable leverage can be achieved for Botswana by granting an access route for the Zambezi Aqueduct, which will fall under Botswana (and hence potentially American) control. This is also an example of what Idealists would identify as functional co-operation acting as a stimulus for regional integration in terms of Functionalist and Neo-Functionalist thinking.

Seen against the background of Lowi's theory of hegemonic co-operation however, this is unlikely to result in significant 'spill-over' and 'enmeshment', as South Africa would not gain by this. It can therefore be concluded that the Idealist models may be unnecessarily optimistic about the role of technical co-operation in regional integration dynamics within arid areas. Functional agreements reached are thus likely to remain highly specific and will probably reflect South African interest the most. Evidence for this can be found in Appendix "E" where a number of the structures are listed as "malfunctioning". This conclusion is tentative however and would need additional research beyond the scope of this study.

It can also be concluded that in terms of the Karshenas model used by Allan, South Africa is at the transition from a 'common' to a 'precautionary' trajectory. This conclusion is tentative however and the transition has not yet physically begun. At best the transition can be seen in terms of policy intentions only. The phase of 'resource reconstruction' is thus not yet evident. The stimulus for this transition was the democratisation of the state in 1994, which enabled the debate on water allocation within the South African political economy to be embarked upon. This coincided with the culmination of a lengthy period of drought, which raised the awareness of both the public and the policy-makers, in much the same way as happened in Israel in 1986. Regarding the SWE of both agriculture and industry, it can be seen that South Africa has a moderate level of efficiency. This conclusion is also tentative due to variances in the data. The wisdom of this policy change is evident however, with significant advantages to be gained by use of the 'virtual water' paradigm as a development strategy. If successfully adopted, it would ensure independence from Botswana, as the Zambezi Aqueduct would not be necessary.

Finally, the significance in terms of the policy shift is that the White Paper on Water Policy is based on a solid foundation of demand side management (DWAF, 1997:6.4; 6.5). This includes amongst other things, the imposition of a tariff structure that reflects the scarcity of the commodity, as well as the allocation of scarce water to economic activities that show the highest return to the national economy.

TANZANIA

Subproblems 1 & 2: Water Scarcity and Population Growth

Recoverable Water Resources

The volume of recoverable water resources for Tanzania is 76 km^3 / yr^{-1} (Table 4a and Appendix "B"). This means that Tanzania has the third largest level of recoverable water resources in the study area.

Population Growth

The population growth figures for Tanzania are as follows (Table 6 and Appendix "B"):

TABLE 52

POPULATION GROWTH FOR TANZANIA

YEAR	MILLIONS
1982	19,11
2000	26,8
2025	52,3

Water Barrier Scale

From the above data, the number of persons / 'flow unit' for Tanzania can be calculated as follows (Table 4a and Appendix "B"):

TABLE 53

PERSONS / 'FLOW UNIT' FOR TANZANIA

1982	2000	2025
250	520	1 100

Hydrological / Population Risk Assessment

When these data are tested against the norm provided for by the WBS as presented in Appendix "D", it can be seen that Tanzania has a moderate level of water competition within its own borders. This corresponds to Position 2 (Mid European Conditions) for 1982 and 2000, and Position 4 (Chronic Scarcity Conditions) by 2025. The impact of a growing population base on resource competition is evident. Tanzania is one of the most populous countries in sub-Saharan Africa, 80% of which is employed in "traditional" (subsistence) agriculture (Economist Intelligence Unit, 1996b:18). It is plagued by refugee problems (Africa Review, 1996:200) from East and Central Africa. When these WBS data are tested against Falkenmark's WSI Matrix presented in Appendix "D", the following data can be derived:

TABLE 54

WSI FOR TANZANIA

1982	2000	2025
12	22	24

Tanzania is in a current position of abundance, with low levels of technological inputs being required to maintain self-sufficiency. In the early part of the next century, Tanzania is likely to begin experiencing scarcity problems, with escalating pressure to maintain self-sufficiency through intermediate levels of technological inputs. The HPRP is low for 1982, medium for the year 2000 and high for the year 2025.

Subproblems 3 & 4: Agricultural and Industrial Sector

The contribution to GDP of each sector indicates the overall economic "mix" of the country. The following sectoral data is provided by the World Bank (1996:18-20) and is presented as a percentage of total real GDP for the year at constant 1987 US Dollar prices.

TABLE 55

SECTORAL CONTRIBUTION TO GDP FOR TANZANIA

YEAR	1987	1988	1989	1990	1991	1992	1993	1994
Agric	46%	46%	46%	47%	49%	51%	52%	52%
Ind	12%	12%	12%	12%	13%	15%	16%	15%

Tanzania has a predominantly agriculturally based economy (Economist Intelligence Unit, 1996b:13). Industry, where evident, is based on the processing of local commodities and on import substitution. Many factories were forced to close down during the 1980s due to power shortages (Economist Intelligence Unit, 1996b:23) and the non-availability of foreign currency (Europa, 1996:954). In terms of GNP per capita, Tanzania is one of the poorest in the world with a high external debt burden, approximately equal to 250% of annual GNP in 1993 (Europa, 1995:2959). This exacerbates the already high HPRP.

Sectoral Water Efficiency Ratio

Only two data sets are available for water consumption. Table 9 only shows agriculture for 1987 expressed as a percentage of total consumption. The World Bank (1996:379) gives sectoral consumption for 1995 expressed as a percentage. These are as follows:

TABLE 56

SECTORAL WATER CONSUMPTION FOR TANZANIA

	TABLE 9	WORLD BANK
	1987	1995
Agric	74%	89%
Ind	n/a	2%

From this the SWE can be derived by comparing sectoral water consumption (Table 56) with sectoral contribution to GDP (Table 55). This is as follows:

TABLE 57

SECTORAL WATER EFFICIENCY FOR TANZANIA

	1987	1995
Agric	74:46	89:52
Ind	? :12	2:15

There is a fair correlation between the contribution side of the two data sets for agriculture, and a good correlation for industry. Consumption figures correlate to an extent. From this it is evident, that in the agricultural sector, a relatively high portion of the total water consumed (approximately 75% in 1987 and >75% in 1995), produces a large contribution to the GDP (around 50%). The agricultural SWE is medium for 1987 and low for 1995. Industry has a low SWE (<25% of GDP contribution) for both data sets. It is known that agriculture has a low 'return to water' so Tanzania can be regarded as a relatively water inefficient state. This is a relative condition however and should not be seen in absolute terms, as the criteria split between low and medium is only 1% off the norm. Given the low level of economic activity, Tanzania is likely to remain a predominantly agricultural economy for some time. The low level of industrial development should be factored into the risk profile, as it has already been shown that intermediate levels of technological inputs will be needed to maintain self-sufficiency. This is problematic when it is expected to come off a low industrial base, so Tanzania has to be regarded as a relatively high-risk country.

Political Factors: Lowi's Variables

Resource Need / Dependence

Around 70% of the electricity generated in Tanzania comes from hydropower (Europa, 1995:2959). Since 1992, aggregate power shortages have been a persistent brake on economic activity (Economist Intelligence Unit, 1996b:23). Water resource need can therefore be considered to be high.

This must be interpreted against the background of a lack of infrastructure to harness the potential of the water that is available, because Tanzania has the third highest level of recoverable resources in the study area. This has a historical basis that started with the *Ujamaa* policy of President Julius Nyerere. The Arusha Declaration, for example, had warned that, "loans and grants will endanger" the independence of Tanzania

(Coulson, 1982:301). This meant that foreign investment was not forthcoming for structural improvements. *Ujamaa* placed an emphasis on peasant farming, with Nyerere constantly pointing out that agriculture had always been the basis of the African economy (Potholm, 1979:81). This led to an active process where agricultural collectives were formed around "*Ujamaa* villages". Subsequent Presidents Mwinyi and Mkapa inherited this legacy. The latter is labouring under the imposition of economic structural adjustment programmes, which reduces spending by government. The need for Tanzania is thus that of infrastructure with which to harness the resources that are available.

Tanzania has access to 4 of the major river basins in the region (Table 1). In order of total river magnitude these are the Zaire (Congo), Zambezi, Rufiji and Kilombero. This position is somewhat distorted however when one considers that only 2% of the country lies in the Zambezi Basin (United Nations, 1978b:6). Thus while the need for water as a resource in general is high, specific reliance on the Zambezi is low.

Rapport de Forces

Tanzania is in a high order riparian position within the Zambezi Basin. Tanzania does not have direct riparian access to the Zambezi River as such, but geographically a portion of Tanzania lies in the overall Zambezi Basin. This does not translate into potential hydropolitical power given the small portion (2%) of total basin area occupied, and the fact that there is no direct access to any of the major tributaries. The potential for withholding supply can therefore not be translated into hydropolitical power.

Tanzania is a recipient country for refugees from Rwanda and Burundi. Tanzania banned the admission of additional refugees from these two states in 1995 (Europa, 1995:2959). Given the fact that Tanzania is amongst the world's poorest countries, and that it is plagued by a high foreign debt (250% of annual GDP in 1993)(Europa, 1995:2959), refugee induced instability could have a domino effect. This could ultimately result in the degradation of the Tanzanian resource base, thereby leading to a net outflow of refugees destined for other parts of the study area. This increases the significance of Tanzania to the rest of the states in the study area.

Character of Riparian Relations

Tanzania provided significant refuge for both the ANC and PAC (Pan Africanist Congress) guerrillas during the anti-apartheid struggle. This means that considerable goodwill exists between Tanzania and South Africa. In the face of the acute balance of payment problems (Europa, 1996:953; Economist Intelligence Unit, 1996b:13) and high external debt (Europa, 1995:2959), this is likely to mean that Tanzania will increasingly look to South Africa for economic support, thus increasing the dependency on South Africa in future.

There is an unresolved but dormant dispute with Malawi regarding the demarcation of the border between the two states. Tanzania claims that the border lies on the median line running through Lake Malawi, and as such that Tanzania enjoys access to the waters of the lake including the use of its resources (Day, 1987:154). This is discussed in the next chapter in more detail.

Tanzania is surrounded by states that have a propensity towards instability. The problems in Rwanda and Burundi have not yet been settled, specifically regarding the newly formed Democratic Republic of Congo. Uganda was involved in the conflict within the Democratic Republic of Congo and faces its own internal instability in the north. Both the civil war in Sudan and the internal unrest in Kenya are destabilising East Africa. Within Tanzania there is a secessionist movement in Zanzibar. This could impact on riparian relations in future.

Of the 22 major agreements that exist between SADC states involving water, Tanzania is a signatory to one (Ohlsson, 1995a:59-60) in addition to the Protocol on Shared Watercourse Systems in the Southern African Development Community (SADC) Region. This is the JCC (Appendix "E").

Conclusion

Tanzania is the second most populated state in the region after South Africa (Appendix "B"). It is also one of the poorest. It is predicted to face Chronic Scarcity Conditions in terms of the WSI by the year 2025. Tanzania is thus being 'squeezed' between a population-induced scarcity and poor economic performance. The legacy of the failure of *Ujamaa* lingers on, resulting in an unfavourable investment environment when viewed from the perspective of a potential foreign investor. In addition to this, the domino effect caused by refugee migration from the Great Lakes Region can result in

Tanzania becoming a significant source of migrants in future. Given the close relationship with South Africa, this is likely to place a burden on the latter. South Africa could translate this into political support within Southern Africa for any hydropolitical aspirations that South Africa may have.

Regarding the SWE for industry Tanzania has a low efficiency. This implies that limited benefits would be derived from adopting a 'virtual water' based development strategy.

ZAMBIA

Subproblems 1 & 2: Water Scarcity and Population Growth

Recoverable Water Resources

The volume of recoverable water resources for Zambia is 96 km^3 / yr^{-1} (Table 4a and Appendix "B"). This means that Zambia has the second largest level of recoverable water resources in the region.

Population Growth

The population growth figures for Zambia are as follows (Table 6 and Appendix "B"):

TABLE 58

POPULATION GROWTH FOR ZAMBIA

YEAR	MILLIONS
1982	6,16
2000	11,24
2025	23,8

Water Barrier Scale

From the above data, the number of persons / 'flow unit' for Zambia can be calculated as follows (Table 4a and Appendix "B"):

TABLE 59

PERSONS / 'FLOW UNIT' FOR ZAMBIA

1982	2000	2025
60	120	250

Hydrological / Population Risk Assessment

When these data are tested against the norm provided for by the WBS as presented in Appendix "D", it can be seen that Zambia has a low level of water competition within its own borders. This corresponds to Position 1 (Well Watered Conditions) for 1982, and Position 2 (Mid European Conditions) for 2000 and 2025. When these WBS data are tested against Falkenmark's WSI Matrix presented in Appendix "D", the following data can be derived:

TABLE 60

WSI FOR ZAMBIA

1982	2000	2025
11	12	12

Zambia is likely to remain in a position of abundance, with low levels of technological inputs being sufficient, well into the next century. Population density is low by African standards, with Zambia being the third most urbanised country on the continent (Europa, 1996:1038). The urbanisation means that it is relatively easier for the government to provide services. Zambia thus has a low HPRP.

Subproblems 3 & 4: Agricultural and Industrial Sector

The contribution to GDP of each sector indicates the overall economic "mix" of the country. The following sectoral data is provided by the World Bank (1996:18-20) and is presented as a percentage of total real GDP for the year at constant 1987 US Dollar prices:

TABLE 61

SECTORAL CONTRIBUTION TO GDP FOR ZAMBIA

YEAR	1987	1988	1989	1990	1991	1992	1993	1994
Agric	11%	12%	12%	11%	12%	8%	13%	11%
Ind	41%	41%	42%	43%	43%	47%	42%	41%

Zambia is predominantly a mining based economy, with the fluctuating world copper price essentially determining economic performance. Copper accounted for 93% of foreign earnings in 1991 (Europa, 1996:1044). It has been estimated that at current extraction levels however, that Zambia only has sufficient reserves until 2010 (Europa 1996:1038). There is thus considerable pressure to find an economic alternative soon. Zambia's main resource is its land, which in general is under-utilised. Zambia ought to be well off, as it has huge agricultural potential and the basic infrastructure for a sound mining-industrial economy (Africa Review 1996:222). Zambia is also rich in potential hydropower (Europa, 1996:1038). Ironically, the end of hostilities in Mozambique and the reopening of trade links with South Africa has had an adverse impact on the economy, mainly due to loss in freight on the Tazara railway line (Africa Review, 1996:224). The economic profile is thus potentially problematic.

Sectoral Water Efficiency Ratio

Only two data sets are available for water consumption. Table 9 only shows agriculture for 1987 expressed as a percentage of total consumption. The World Bank (1996:379) gives sectoral consumption for 1995 expressed as a percentage. These are as follows:

TABLE 62

SECTORAL WATER CONSUMPTION FOR ZAMBIA

	TABLE 9	WORLD BANK
	1987	1995
Agric	26%	77%
Ind	n/a	7%

From this the SWE can be derived by comparing sectoral water consumption (Table 62) with sectoral contribution to GDP (Table 61). This is as follows:

TABLE 63

SECTORAL WATER EFFICIENCY FOR ZAMBIA

	1987	1995
Agric	26:11	77:11
Ind	? :41	7:41

There is an exact correlation between the contribution side of the two data sets for both sectors. Consumption figures vary significantly however. The data set is clearly flawed in this case. This variance makes it difficult to assess the sectoral efficiency of agriculture so the result is an anomaly. The agricultural SWE is high for 1987 and low for 1995. It is known that agriculture has a low 'return to water' in general though. The sectoral efficiency of industry looks better, with a high SWE in terms of the criteria used for both data sets. With the abundance of water in Zambia, questions of efficiency are not that relevant at present, but given the known hydropower potential, this could drastically increase the efficiency if harnessed in future.

Political Factors: Lowi's Variables

Resource Need / Dependence

Zambia has the second highest volume of recoverable water resources in the study area (Appendix "B"). Zambia has access to 4 of the major river basins of the region (Table 1). In order of magnitude these are the Zaire (Congo), Zambezi, Kafue and Luangwa. The Kafue and Luangwa are sub-basins of the Zambezi. The Zaire (Congo) is the largest river and Zambia lies in 4,7% of the total basin (United Nations, 1978a:5) which is a significant share. Over 40% of Zambia lies in the Zambezi Basin however (United Nations, 1978a:6), which is the largest share of the Zambezi. Surface water capacity is thus considerable.

Water development in Zambia has been dominated in the past by hydropower and water supply. Abstraction for large urban populations is mostly from surface water, especially in the Copperbelt region. Irrigation is generally a poorly developed water user in Zambia. Agriculture has been a poorly neglected sector of the economy, with emphasis placed more on mining and related processing industries. Rainfall is adequate for rainfed production without the use of irrigation technology (MacDonald *et al.*, 1990d:2.5). There is a large reserve capacity in existence. For example, considering Kafue alone, the present installation only uses 400-m of the 600-m head available. An additional development at Kafue, could increase the generation at the existing site by almost 50%, without the need for further regulation facilities (MacDonald *et al.*, 1990d:2.14). Zambia is self-sufficient in hydroelectric power generation (Europa, 1993:3270). Zambia's main resource, besides water, is its land that in general is under-utilised (Europa, 1996:1038). The potential for 'virtual water' export is thus considerable. Zambia currently exports hydroelectric power to Zimbabwe as an existing example of this, with potential to produce agricultural produce for sale to the more arid states in the study area.

Low water levels throughout the study area during the 1991/2 drought reduced power output in Zambia, resulting in a suspension of exports. Zambia became one of the states that needed to import power from ESCOM and Zaire (Europa, 1996:1046). This indicates that the current resource need is high, and also serves to illustrate the need to develop a regional power grid that is based on a combination of thermal (coal fired) power generating plant, as well as hydropower plant, in order to maintain generating stability during years of drought.

Rapport de Forces

Zambia is a relatively weak state measured in terms of economic and military capacity. Internal political instability can become a detrimental factor in future. President Chiluba is intolerant of political opposition. There was a *coup d'etat* attempt in late 1997 and former President Banda has been arrested for alleged complicity with this. The end of hostilities in Mozambique has had a negative effect on Zambia, as it reduced traffic on the TAZARA railway line (Africa Review, 1996:224). Agricultural capacity is being improved with the resettling of commercial farmers from South Africa (Africa Review, 1996:224). On the Zambezi River, Zambia is a high order riparian, a position that is traditionally strong.

The efficient utilisation of the hydroelectric power resources on the Zambezi River and its main tributaries, can only be realised by the conjunctive operation of the main hydropower stations, namely Livingstone (Victoria Falls), Kariba South, Kariba North, Itezhi-Tezhi and Kafue. This would also apply to the proposed Batoka Gorge Dam, and when security conditions permit, the system would benefit from the inclusion of Cahora Bassa. This would bring considerable savings, as well as result in an impetus to integration. It has been shown that the conjunctive operation of Kariba and Kafue alone would yield 962 GWh of additional energy per year (Knight Piésold *et al.*, 1993:ix). The proposed Batoka Gorge Dam is a source of potential tension, as it raises ecological issues due to the inundation of the rapids up to the base of Victoria Falls.

In strictly hydropolitical terms, the *rapport de forces* position of Zambia is relatively strong, if one considers the following three factors: Firstly, the proposed Lualaba-Zambezi IBT will elevate Zambia to a position of strategic significance for South Africa. Secondly, the planned water abstraction for Botswana, elevates Zambia to a position of strategic importance to that country. Thirdly, this position of power can be maximised by Zambia if the abstraction point is finally agreed as being upstream of Katima Mulilo on the Zambezi River, as this location can feed Grootfontein in Namibia, Francistown in Botswana, Gauteng in South Africa and Bulawayo in Zimbabwe (Alexander, 1996). Thus, if Zambia adopts a strong negotiating stance, that results in the final placement of the abstraction point wholly within Zambia and opposes the Batoka Gorge project, then in purely hydropolitical terms, Zambia becomes elevated to probably the single most important power in the study area, at least on the supply side of the hydropolitical equation.

Character of Riparian Relations

There is a security agreement with Angola that ensures common border control (Europa, 1993:3270). Zambia gave support to guerrilla opposition groups in Rhodesia and Mozambique, thereby becoming a target for counter-attack (Europa, 1996:1039). There is a reservoir of political goodwill with these two countries as a result. Zambia was a close ally of the ANC during the anti-apartheid struggle, and thus enjoys good relations with the South African government. The BotZam highway links Kazungula in Zambia with Nata in Botswana, increasing the interdependence of these two states. There was an agreement with Namibia in 1994, to build a bridge across the Zambezi River, to facilitate cross-border passage and to enable Zambia to use Walvis Bay as a harbour (Europa, 1996:1046). There is a close relationship with Zimbabwe as a result of the Kariba Dam and proposed Batoka Gorge Dam. The latter can result in tension between the two states, as Zambia does not wish to proceed with the proposed Batoka Gorge project, because it will inundate the Zambezi River up to the base of the Victoria Falls. Zambia fears that this will result in the loss of eco-tourist revenue (refer to the discussion under Zimbabwe). Being landlocked has resulted in the need for Zambia to maintain generally good relations with neighbouring states.

There was a border dispute with the former Zaire in the Lake Mweru region that started in 1982. This resulted in an exchange of fire and the subsequent capture of Zambian soldiers by Zaïreans (Day, 1987:194). This continued until 1987 when President Kaunda announced that the dispute had been resolved. There have been a few limited disputes of a similar nature with Malawi. The reader is referred to the discussion under Malawi.

Of the 22 major agreements that exist between SADC states involving water, Zambia is a signatory to two (Ohlsson, 1995a:59-60) in addition to the Protocol on Shared Watercourse Systems in the Southern African Development Community (SADC) Region. These are the PCC and the ZRA (Appendix "E").

Conclusion

Within the post-apartheid Southern African region, Zambia has the capacity to become a major exporter of 'virtual water', both in the form of hydroelectric power and agricultural produce. This can elevate Zambia in hydropolitical terms to that of a major player within the study area, but only if Zambia can overcome the existing problems that are experienced with poor agricultural production. There is thus a large gap between potential and actual capacity. The vulnerabilities of the study area to drought, mean that a stable electricity supply can only result from an integrated regional grid that is powered by both hydroelectric and thermal plant, increasing the co-operative dynamics within the study area. The Batoka Gorge Dam is a source of potential tension as Zambia is opposed to the development, but Zimbabwe wishes it to proceed. Should the Batoka Gorge project proceed in preference to the diversion of water upstream of Victoria Falls, then Zambia will reduce its own power position when viewed in strictly hydropolitical terms.

One of the main advantages that Zambia has, in terms of internal developmental capacity, is the low level of water competition. Population growth does not have the same negative potential impact as it does in many of the other states in the study area.

In terms of the SWE for agriculture, there is no strong trend evident for Zambia. The industrial SWE reveals a higher level of efficiency however, but the data set is too limited to be conclusive. This implies that Zambia is likely to benefit from the adoption of a 'virtual water' based development strategy, and presuming that the agricultural potential could be realised, Zambia has the capacity to become a 'virtual water' exporter in a regional context.

ZIMBABWE

Subproblems 1 & 2: Water Scarcity and Population Growth

Recoverable Water Resources

The volume of recoverable water resources for Zimbabwe is 23 km^3 / yr^{-1} (Table 4a and Appendix "B"). The World Bank (1996:379) quotes a similar figure (20 km^3). This means that Zimbabwe has the second lowest level of recoverable water resources in the study area.

Population Growth

The population growth figures for Zimbabwe are as follows (Table 6 and Appendix "B"):

TABLE 64

POPULATION GROWTH FOR ZIMBABWE

YEAR	MILLIONS
1982	7,93
2000	15,13
2025	32,7

Water Barrier Scale

From the above data, the number of persons / 'flow unit' for Zimbabwe can be calculated as follows (Table 4a and Appendix "B"):

TABLE 65

PERSONS / 'FLOW UNIT' FOR ZIMBABWE

1982	2000	2025
350	660	1 400

Hydrological / Population Risk Assessment

When these data are tested against the norm provided for by the WBS as presented in Appendix "C" and "D", it can be seen that Zimbabwe has a significant level of water competition within its own borders. This corresponds to Position 2 (Mid European Conditions) for 1982, Position 3 (Water Stressed Conditions) for 2000 and Position 4 (Chronic Scarcity Conditions) by 2025. When these WBS data are tested against Falkenmark's WSI Matrix presented in Appendix "D", the following data can be derived:

TABLE 66

WSI FOR ZIMBABWE

1982	2000	2025
12	23	24

Zimbabwe had a level of abundance with low levels of technological inputs being needed in 1982. By 2025 conditions of scarcity are likely to prevail, with intermediate levels of technology being needed to maintain self-sufficiency. Zimbabwe thus had a low HPRP for 1982, but has a high HPRP for the years 2000 and 2025.

Subproblems 3 & 4: Agricultural and Industrial Sector

The contribution to GDP of each sector indicates the overall economic "mix" of the country. The following sectoral data is provided by the World Bank (1996:18-20) and is presented as a percentage of total real GDP for the year at constant 1987 US Dollar prices:

TABLE 67

SECTORAL CONTRIBUTION TO GDP FOR ZIMBABWE

YEAR	1987	1988	1989	1990	1991	1992	1993
Agric	13%	14%	13%	12%	12%	10%	14%
Ind	32%	30%	31%	31%	31%	31%	30%

Although Zimbabwe has one of sub-Saharan Africa's most successful agricultural sectors, agriculture ranks third behind services and manufacturing in terms of GDP contribution (Europa, 1996:1065). Zimbabwe is better placed than most to withstand the effects of commodity price fluctuations. In 1985 Zimbabwe became the first African state to donate food aid to Ethiopia. This was repeated again in 1988 with Zimbabwean grain being sent to Malawi, Botswana and Mozambique. In 1990 the World Food Programme distributed Zimbabwean grain to drought victims in Angola, Malawi, Mozambique and Zaire. While Zimbabwe has only been forced to import maize three times in the last 75 years (Europa, 1996:1066), it consistently fails to meet its domestic wheat consumption needs (Europa, 1996,1067). Zimbabwe has an unusually high export diversity for an African state (Europa, 1996:1069) being much more diversified than all of its neighbours, except South Africa. Yet agriculture still dictates the health of the economy (Economist Intelligence Unit, 1996c:8). The reason for this is the fact that relatively high value crops such as tobacco are produced, essentially for the export market. This in turn means that foreign revenue is generated by these exports. This revenue is circulated throughout the economy with a multiplier effect being felt. The international tobacco lobby is worrying for Zimbabwean tobacco farmers however, and some are starting to diversify into high value crops such as flowers, which are being exported to Europe.

Oddly enough, the strength and diversity of the economy lies in the history of post-UDI sanctions at which time local manufacturing flourished (Economist Intelligence Unit, 1996c:23). The significance of this fact is that the manufacturing sector is still largely geared for own internal use only. Generally products are made in Zimbabwe whenever possible. The shortage of foreign currency is still a major inhibiting factor for imports into the country. Some of these locally produced products can be quite sophisticated. While this is a good policy to have, it also means that Zimbabwean manufactured products are generally not competitive on the global market and their production is only viable within the context of their own economy. The combination of this factor with the point raised above (on the significance of agricultural exports), means that agriculture still remains an important earner of hard currency. This elevates the importance of the agricultural sector. The structure of the Zimbabwean GDP thus differs markedly from that of most of its neighbours (Economist Intelligence Unit, 1996c:13). There is considerable tension within the agricultural sector however, with strong calls being made by landless peasants to seize white commercial farms and redistribute them more equitably (Grant, 1997).

The development of water resources remains a pressing need that has generally been met by a major dam building programme (Europa, 1996:1059). Zimbabwe has approximately 6 500 dams at present (Mujuru, 1997) and farmers are being actively encouraged to build as many as they can on their own property (Hickman, 1997). There are ecological problems that are emerging as the result of this policy however, as most small streams and rivers have had their normal flow totally attenuated. The absence of scouring floods means that watercourses are now silting up and *Phragmites* overgrowth is becoming a major problem (Grant, 1997). This is strong evidence of the existence of a supply side management philosophy. The irony of the development of Lake Kariba is that no agricultural use is made of this resource due to prohibitive pumping costs (Swatuk, 1996:41).

Sectoral Water Efficiency Ratio

Only two data sets are available for water consumption. Table 9 only shows agriculture for 1987 expressed as a percentage of total consumption. The World Bank (1996:379) gives sectoral consumption for 1995 expressed as a percentage. These are as follows:

TABLE 68

SECTORAL WATER CONSUMPTION FOR ZIMBABWE

	TABLE 9	WORLD BANK
	1987	1995
Agric	79%	79%
Ind	n/a	7%

The SWE can be derived from this by comparing sectoral water consumption (Table 68) with sectoral contribution to GDP (Table 67). This is as follows:

TABLE 69

SECTORAL WATER EFFICIENCY FOR ZIMBABWE

	1987	1995
Agric	79:13	79:14
Ind	? :30	7:30

There is a near exact correlation between the two data sets for both sectors. Given the high consumption on agriculture (>75% for both years) and the resultant low contribution to GDP (around 14%), the agricultural sectoral water efficiency is low for both data sets. The better efficiency of industry is clearly evident, where less than 10% of the water generated a GDP contribution almost double that of agriculture. This is regarded as a medium SWE for industry for both data sets. This is a classic demonstration of Allan's (1996b) hypothesis and suggests that the potential benefit of 'virtual water' is considerable.

An interesting point can be made about this "supply side mentality" that Zimbabwe has based on personal observation. The author was taken on an inspection of certain of the water-related facilities in Zimbabwe, as part of a delegation from the Second Water and Wastewater Conference, which was held in Harare from 15-18 September 1997. At one site, the Chivero Dam project was presented to the delegates as an example of the success of Zimbabwe's water policy. The design of this dam is questionable as it stops the total flow of the river. *Phragmites* overgrowth was clearly evident in the dry riverbed downstream of the dam as a result of this reduction in minimum flow. Dr. Grant (1997) announced that this is a problem in Zimbabwe in general and is being treated with herbicides. This is a questionable policy in modern ecological terms as these herbicides enter the ecosystem and are later distributed by the hydrological cycle. Should the herbicides eradicate the *Phragmites,* then significant bank erosion is likely to occur during future flood events, with resultant siltation of impoundments. The maintenance of a minimum instream flow is widely recognised as being vital to the long-term ecological sustainability of any river system. In Zimbabwe this fact is apparently ignored and does not form part of the operating rules for impoundments as it does in South Africa (in keeping with the White Paper on Water Policy) and elsewhere. The implication of this is that environmental collapse is likely within the given river system, as the ecological functioning ceases due to zero flow between flood events. In other words, such a design implies that the river is either in flood, or in a state of zero flow.

Alongside the dam a number of peasant farmers have been resettled. They have each been given a plot of land on which they cultivate wheat under irrigation. They pay nothing for the water and electricity that is used for pumping purposes. Thus two major input costs are merely ignored in the overall economic equation of the project. To the majority of the conference delegates in the group, all of whom were international in origin, this was regarded as a highly questionable practice. The conclusion by the group of foreign specialists after the tour was that the Lake Chivero project is not economically viable, and is in fact motivated purely by political factors which emanate from the strong desire amongst rural constituencies for land redistribution. The Lake Chivero project is in fact being given a high profile in the state-controlled media, as an example of the success of the government's policy.

Political Factors: Lowi's Variables

Resource Need / Dependence

Zimbabwe has the second lowest level of recoverable water resources in the study area. In addition, Zimbabwe has the fourth highest projected population for the year 2025 (Appendix "B"). Zimbabwe has access to 3 of the major river basins in Southern Africa (Table 1). In order of magnitude these are the Zambezi, Limpopo and Save. While Zimbabwe has a well-developed infrastructure, mineral wealth and a highly diversified manufacturing sector, agricultural development has been adversely affected by frequent drought (Europa, 1995:3500).

Although Zimbabwe has one of sub-Saharan Africa's most successful agricultural sectors, agriculture ranks third behind services and manufacturing in terms of GDP contribution (Europa, 1996:1065). Because agriculture still dictates the overall health of the economy (Economist Intelligence Unit, 1996c:8) the development of water resources has been a pressing need, which has been met by a major dam building programme as groundwater is generally limited (Europa, 1996:1059). There are currently over 100 dams registered with the International Commission on Large Dams (MacDonald *et al.,* 1990e:2.6). Again this is evidence of the prevailing supply sided management mentality already noted above.

Zimbabwe shares Kariba Dam with Zambia, and it imports a significant amount of power from Zambia. In 1987 Zimbabwe added 920 MW of new thermal capacity, located at Hwange, to its own national grid, eliminating the need for these imports.

The performance of Hwange has been disappointing however, owing to design faults and a shortage of spare parts. There has been electricity rationing in Zimbabwe, and 500 MW was purchased from Cahora Bassa in 1992. As a result, Zimbabwe is pushing for the Batoka Gorge Dam, which is scheduled to cost Z$ 1 000 m and which is to add 800 MW of capacity by the year 2003 (Europa, 1996:1070). Batoka Gorge is said to be the cornerstone of Zimbabwean planning (MacDonald *et al.*,1990e:2.14). This provides a good example of national self-interest at work, opposing regional integration dynamics that are based on technical functional co-operation, as Cahora Bassa could provide this capacity. Presumably, this option is not being considered as it would strengthen Mozambique and weaken Zimbabwe in relative hydropolitical terms, as Zimbabwe tends to view these matters as a zero-sum game.

Since 1991, a dispute has been developing between the city of Bulawayo and the central government, over water supply. The Matabeleland Zambezi Water Project (MZWP) argues that a pipeline from the Zambezi River is the only long-term solution, and accuses the government of dragging its feet on the issue as shortages reached crisis proportions during the 1992 drought (Economist Intelligence Unit, 1996c:10). This can be linked to the internal political cleavage between the Mashona, who are the ruling elite found mostly in ZANU(PF) and the Matabele, the political minority found mostly in ZAPU (and geographically located around Bulawayo). Efforts have been made to reduce this tension with the Unity Accord, which was designed to integrate the two parties. In terms of this accord, Joshua Nkomo was made Vice-President. In spite of this, tensions are reported to persist however.

An explanation for this can be the fact that there are insufficient funds available to support this major project, and this delay is being interpreted by people that are being negatively affected, as deliberate political machination. The water for the MZWP can be provided from an abstraction point upstream of the Victoria Falls (Alexander, 1996), but will increase the Zimbabwean reliance on Zambia, which is anathema to the national self-sufficiency posture that Zimbabwe has chosen to adopt. An international delegate to the Second Water and Wastewater Conference, which was held in Harare from 15-18 September 1997 (who wished not to be quoted as he feared it may result in his movements being restricted in future), told the author that the MZWP was linked to the Batoka Gorge project. The rationale given was the fact that a major limiting factor in the economic viability of the MZWP is the cost of lifting the water from the Zambezi Valley to Bulawayo. This is termed 'head' in engineering terminology and accounts for the energy input needed to move the water. The 'head' therefore determines the long-term operating cost of a project, which in turn impacts on the viability. If the Batoka Gorge Dam were to be built, this would reduce the head to almost a quarter and therefore reduce the operating costs considerably. At the same time, energy would be produced in sufficient quantities as to improve the viability of the MZWP.

Additional proof of the folly of a strictly supply sided management approach is evident when one analyses the tariff structures of water in Zimbabwe. The subsidisation of water supply is heavily biased in favour of the 4 000 commercial farmers who control 83% of the irrigated land. They pay Z$47 per megalitre, compared to the economic price of about Z$376 per megalitre. This is an effective subsidy of Z$400m (US$42m) annually (Economist Intelligence Unit, 1996c:22). The effect of this is an increase in demand with the resultant uneconomic use of the water on low value crops. This is contrary to the principles of 'virtual water'. This supply sided approach actually encourages uneconomic use of water and hence exacerbates the water scarcity problems being experienced. It has been shown that abstraction of water from the Zambezi for purposes of irrigation is hopelessly uneconomic, mostly due to the considerable pumping needed to lift the water up to the irrigated lands (MacDonald *et al.,* 1990e:2.2). This is in keeping with the opinion of the anonymous delegate to the Second Water and Wastewater Conference quoted above. The horticultural industry has become one of the emerging exporters, with Zimbabwe ranked as the third largest rose exporter in the world (Economist Intelligence Unit, 1996c:26) and the fourth largest supplier of flowers to Europe (Africa Review, 1996:230). This is an example of the effective use of irrigation water, as high value crops are being produced and additional expansion is thus in harmony with the 'virtual water' concept. This recent development is thus sustainable.

It can therefore be said that the resource need is high for Zimbabwe. This state demonstrates a specifically strong national self-sufficiency posture, resulting originally from the response to UDI induced sanctions, which suggests that Zimbabwe is likely to be unsympathetic to the potential benefits of 'virtual water' and the regional co-operation necessary in this regard. Realism is thus likely to prevail over Idealism in the case of the second most diversified economy in the study area. This supply sided approach is also likely to increase tensions with South Africa, if the latter should gain access to the waters of the Zambezi, as such an approach tends to result in the view that other users are opponents. Such an approach therefore has a natural inherent conflict-creating dynamic as it is based on the zero-sum principle.

Rapport de Forces

Of the shared river basins in the region, Zimbabwe is in a high order riparian position on the Limpopo and Save. On the Limpopo River, Zimbabwe sees potential for expanding irrigation (Conley, 1996c:35), which can increase tensions with South Africa. On the Zambezi River, Zimbabwe is in a middle order riparian position. If South Africa succeeds in negotiating access to the waters of the Zambezi Basin via Botswana, then Zimbabwe would be reduced to the status of a lower order riparian with reduced supply prospects at least until the Lualaba-Zambezi IBT is developed.

The Zimbabwean military establishment is about three times larger than the African average in relation to population (Economist Intelligence Unit, 1996c:8). The defence sector was allocated 9,5% of total budgetary expenditure in 1994/5, and Zimbabwe had troops stationed in Mozambique between 1982 and 1993. There were approximately 250 000 Mozambican refugees in Zimbabwe in 1992 (Europa, 1995:3500). Zimbabwean troops have served under the UN during operations in Mozambique, Rwanda, Somalia and Angola (Europa, 1996:1065).

Zimbabwe depends largely for foreign trade on rail links to harbour facilities in Mozambique and South Africa (Europa, 1996:1059). This is because of the land-locked nature of the country, which increases dependence on the Beira, Maputo and Limpopo corridors. Zimbabwe is thus highly dependent on Mozambique.

Given the ongoing power shortages, Zimbabwe is pushing for the development of the Batoka Gorge Dam. This will make it largely independent in terms of power generation and is a prime example of the paradigm of national self-sufficiency. Zambia is opposing this, so tensions may result between the two states concerned.

Significantly, in terms of the SADC Water Protocol, Zimbabwe is taking the lead in establishing a basin wide regime for the Zambezi (Tumbare, 1997). This involves the expansion of the existing Zambezi River Authority (ZRA) which was originally created to manage Kariba Dam. Only Zambia and Zimbabwe are members of the ZRA. Zimbabwe is the dominant power in the ZRA at present, and would presumably like to keep this position in the expanded regime. The interesting aspect of this development is that it is in keeping with Lowi's theory of hegemonic co-operation, as Zimbabwe is both the hegemon in the configuration, and would stand to gain the most by co-operation. When the author asked various executives of the ZRA what the chances of South Africa being included in this regime were, the universal response was a negative one. This suggests to the author that Zimbabwe, as the hegemonic power in the Zambezi Basin, would like to maintain this status, and would thus oppose possible South African aspirations to gain access. The unit of analysis of the current study is the Zambezi Basin *plus* South Africa, so in this expanded configuration, South Africa is the hegemon. The result is thus the likelihood of a high level of competition between Zimbabwe and South Africa in hydropolitical terms.

President Mugabe chairs the SADC Organ on Politics, Defence and Security and as such plays a dominant role. This can provide the military establishment within Zimbabwe a degree of consolation in the face of possible economic structural adjustment programme induced downsizing that appears eminent. This possible military downsizing can have two potential effects. Firstly, the evidence provided by the many *coups' d'etat* in Africa, suggests that the military become disaffected when attempts at downsizing impacts adversely on them. There is already a degree of internal unrest present, emerging ostensibly from disaffected liberation struggle combatants who feel that they have not been adequately compensated for their role in ending colonialism. Secondly, the downsizing of the Zimbabwean military can reduce the overall power position of that state with respect to neighbouring Botswana.

Character of Riparian Relations

While maintaining cordial relations with South Africa, Zimbabwe is afraid that the latter may be more attractive to foreign investors (Africa Review, 1996:228). The emergence of a post-apartheid South Africa has caused Zimbabwe to lose some of the regional pre-eminence it once enjoyed, and political and economic relations with its mighty, if now friendly neighbour, will continue to be a dominant concern for Zimbabwe (Europa, 1996:1065). Ironically, Zimbabwe has strong political ties with the PAC, which is now one of the opposition parties in the newly democratic South Africa. Therefore political goodwill between Zimbabwe and South Africa is not necessarily as strong as it could be. The previously noted public display of rivalry between Presidents Mugabe and Mandela at the establishment of a summit for the SADC Organ on Politics, Defence and Security (Sunday Independent, 14/9/97) is another indication of this. There are good relations with Mozambique.

Of the 22 major agreements that exist between SADC states involving water, Zimbabwe is a signatory to 2 (Ohlsson, 1995a:59-60) in addition to the Protocol on Shared Watercourse Systems in the Southern African Development Community (SADC) Region. These are the LBPTC and ZRA (Appendix "E"). Zimbabwe and

Botswana are currently in bilateral talks over the establishment of a regime for the Ramokgwebana River (Gilbu, 1997). In addition to this, Zimbabwe is leading the way by using the SADC Water Protocol to establish a basin-wide authority for the Zambezi (Tumbare, 1997) that is based on the expansion of the ZRA, which it currently dominates.

Conclusion

Zimbabwe can be classified as a significant regional power that has a strongly institutionalised national self-sufficiency posture. This implies that in terms of functional regional co-operation, it may be a reluctant partner unless it stands to benefit directly as a result. This is seen to be compatible with Lowi's theory of hegemonic co-operation. This conclusion is based on the history of self-sufficiency, which has implied that environmental degradation has become the "acceptable" price to pay for self-sufficiency. In terms of the Karshenas model used by Allan, it can be concluded that Zimbabwe is still clearly on a 'common' developmental trajectory with no visible signs of considering a policy adjustment to a 'precautionary' trajectory. In hydropolitical terms, this is likely to manifest itself in a strong desire to develop the Batoka Gorge Dam, in spite of the international environmentalist opposition to the project. Zimbabwe is likely to oppose Zambia during negotiations on the possible siting of the abstraction point for Zambezi water, which for Zambia would preferably be upstream of Katima Mulilo. Zimbabwe displays a strong "supply side mentality", manifesting itself in a major dam building effort and water subsidisation approaches. In this, it is very similar to what South Africa was, prior to 1994.

Regarding the SWE for agriculture, Zimbabwe displays a low level of efficiency. This is an anomalous situation, as Zimbabwe is known to have a history as an agricultural exporter. Further research would probably indicate that this agricultural export could lead to higher water demands and thus lower efficiency. If this were so, then Zimbabwe would probably benefit more by using the available water for industrial development rather than agricultural development. Regional differences within Zimbabwe could impact on this. In the eastern part, water-intensive tobacco is grown, while in the central Mashonaland highlands and savannah, less water-intensive beef production dominates. The dominance of tobacco is also a factor, especially in face of the increasingly powerful international anti-tobacco lobby. Another factor of significance is the fact that agriculture in Zimbabwe is the power base of the white community. It is therefore difficult to reduce the importance of this sector as they still represent a concentration of economic power. In the final instance, the potential advantages of a 'virtual water' development strategy, will not be the only consideration.

The industrial SWE indicates a medium level of efficiency. This in turn would imply that an export orientation for the industrial sector could result in the earning of hard currency. Given the diverse nature of the economy and the clear existence of a better 'return to water' in this sector, Zimbabwe would probably benefit from the adoption of a 'virtual water' based development strategy. This may well be forced on Zimbabwe in much the same manner as that experienced by both Botswana and South Africa.

The Impact of SWE Data in General

A specific conclusion must be noted regarding the impact of the limited data sets that are used to determine the SWE. In the case of certain states, the data from Table 9 and the World Bank (1996) was in harmony. This enabled a more conclusive result to be reached. However, in certain cases, there were variations between the two data sets used. In these cases, the results were reported as being inconclusive. This highlights a primary weakness in the research. The methodology appears to be adequate, because the various indicators such as the WBS, WSI and the SWE do in fact enable a link to be made between important hydropolitical variables. The fundamental problem with this however, is the fact that there is a paucity of accurate data for the study area. This cannot be wished away and is in fact recognised by SADC, the Development Bank of Southern Africa and various government departments. The truth is that better data is simply not available. Therefore, rather than blame the methodology as being inadequate, the actual root cause of the problem lies in essentially three areas. These are:

Firstly, there is a critical lack of accurate data that shows the water usage by sector from each of the states in the study area. Under the circumstances, the best available material was used, but it is fully acknowledged by the author that this lack of data poses a fundamental problem to the research effort. This problem is not insurmountable however, as a result was obtained in most cases. The methodology therefore cannot be blamed where a result was inconclusive.

Secondly, the data does not show movement over time. This would be extremely valuable and would enable the impact of a policy decision to be seen on the actual water consumption. A good example would be for Botswana, where a policy shift has been made, but no evidence of this is seen in the existing limited data sets; or for South

Africa, that is making a major policy shift as evidenced by the White Paper on Water Policy, and would thus have the need to monitor the impact of this policy on actual water consumption.

Thirdly, the norms that were arbitrarily determined by the author are not sufficiently streamlined. This is particularly evident from the SWE analyses where the concept of more or less efficient use of water needs to be determined. This must be seen against the background that this methodology is new and consequently there is no outside reference from which to determine the parameters of a norm. At best, the relative efficiency between each of the economic sectors - agriculture and industry - within a given state, could be seen. There is strong evidence that agriculture has a lower 'return to water' than industry. There is evidence of this in almost all states analysed. This can be concluded to be a general case. What the available parameters do not provide for, is the ability to say that one country is more efficient than another in a given sector. This is a problem that should be considered when, and if, any other research is done in the future that uses a similar methodology.

In conclusion then, the methodology appears to be a sound one, as it does in fact link key hydropolitical variables. This in turn enables a meaningful analysis of a complex issue to be made, and the root causes of the problem of water scarcity to be better understood. In most cases, the problem of water scarcity, is in fact only a manifestation of the problem, with the root causes actually being rapid population growth.

CHAPTER 4

ANALYSIS OF SPECIFIC RIPARIAN DISPUTES

Introduction

Water scarcity in general has been identified by a number of authors as a potential cause of future interstate conflict (Critchley, *et al.*, 1993:332; Homer-Dixon, 1994:5-40; 1996:9). This is also recognised in the Introduction to the South African White Paper on Water Policy (DWAF, 1997). Other authors use terms such as "intensified competition" (Hudson, 1996:8) and "warfare" (Davies *et al.*, 1996b; Starr, 1991). Water scarcity has been identified by Ohlsson (1995a:1) as potentially the greatest future cause of conflict in the Southern African region. Thus we have a rather pessimistic picture being painted by a number of authors. On the other hand, Allan (1996f:114) notes that despite the confidently predicted "water wars", there is no such evidence of these materialising in the Middle East. It therefore becomes necessary to analyse specific riparian disputes within the context of the Zambezi Basin riparian states for six reasons:

Firstly, the concept of 'virtual water' implies that a high degree of co-operation is needed. Ongoing conflict over riparian related issues thus runs contrary to the use of 'virtual water' as a potential solution. Riparian conflict, where present, should be dealt with by an appropriate structure if the necessary co-operation is to be allowed to develop.

Secondly, it is necessary to determine if the likelihood of the use of force for the resolution of riparian disputes is a 'core value'.

Thirdly, it gives an insight into the way in which riparian conflicts can start over one specific issue, and subsequently escalate in such a manner as to ultimately embrace an entirely different issue.

Fourthly, the analysis of each state in the study area that was completed in the previous chapter was not conducive to a satisfactory presentation of this particular subject material. This is a manifestation of the dilemma regarding the most appropriate approach that has been previously alluded to. In the context of this dilemma, a specific riparian dispute exists by definition between more than one party. It is therefore better analysed by using an approach that differs to that used in the previous chapter with its inherent state-centric focus.

Fifthly, the central issue in each dispute revolves around access to water and the resources that are associated with it. This in turn is directly linked to the first and second subproblems. The logic for this is that increased water scarcity is partly caused by population pressures. This effects the ability of a state to provide for its citizens. This in turn impacts on the perception that a state has when a threat (either real or imagined) to uninhibited access to that resource-base is detected. In the final instance, a state that is faced with a combination of water scarcity and a growing population, needs to feed and create livelihoods for that expanding constituency. Such a state can thus not tolerate another state's potentially hostile aspirations to a strategically vital resource such as water.

Sixthly, at one point in the Kasikili-Sedudu dispute, the failure to resolve the conflict was blamed on the SADC Water Protocol. It is thus important to determine what the context of this was, and if the Protocol is indeed flawed.

Kasikili-Sedudu Island Dispute

In terms of media coverage, the disputed island "almost started a war" between the two states (SAPA, 15 February 1996). This conflict provides an interesting example of how a dispute escalates, along with the role that perceptions play in this regard. The dispute initially started off, ostensibly as a border dispute over an obscure uninhabited island of approximately 3,5 km^2 in the Zambezi basin, and ultimately ended up by being linked to both an arms build-up and conflict over the abstraction of water from a totally different basin (Kavango). At the time of writing, this issue has not been resolved, and can still be regarded as "being on the boil".

Physical Orientation

The small island is on the border between Namibia and Botswana in the eastern Caprivi Strip. It is physically located on the Chobe/Linyati River between the Zambezi and Lake Liambezi (Africa Analysis, 1996:6) just east of the point where Zambia, Zimbabwe, Botswana and Namibia converge. The Chobe/Linyati River is a major tributary of the Zambezi River and it crosses the Caprivi Strip from Angola as the Cuando River. The eastern extreme of the Caprivi Strip is bordered to the north by the Zambezi River and to the south by the Chobe/Linyati River. A peculiarity in the context of Namibia is that the Caprivi Strip is one of the best water resource endowed areas in the whole country, and is thus of major importance to this otherwise arid state. The island is uninhabited and is submerged under water for most of the year. Figure 17 is a map of the area in order to orientate the reader.

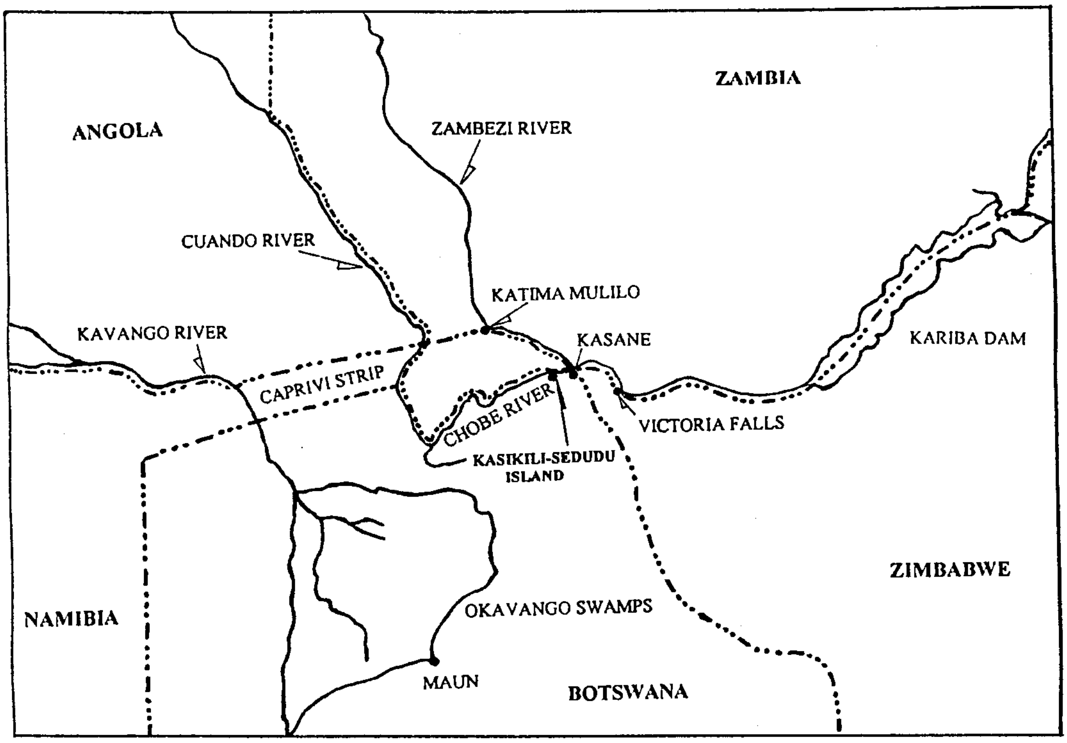


Figure 17. Map showing the location of Kasikili-Sedudu Island.

Evolution of Events Linked to the Kasikili-Sedudu Dispute

The dispute is the result of an ambiguity in the 1890 Anglo-German Treaty (Vines, 1996:6). This Treaty has different possible interpretations as a result of this ambiguity. The original treaty defined the border as the deepest part of the river, which was south of the island at that time. This is no longer the case and the deepest channel is now north of the island, with the southern channel having consolidated somewhat with the riverbank. Botswana is thus claiming sovereignty over this island in view of the changed circumstances.

Namibia became independent in 1990 after the "free and fair" elections which were conducted under the auspices of the UN Transition Assistance Group (UNTAG) in 1989. Border tensions between Botswana and Namibia grew in 1991, when Botswana deployed forces on the Kasikili-Sedudu Island and hoisted its flag. Shots were fired over possession of the Kasikili-Sedudu Island (Africa Research Bulletin, 1996:12147) but no casualty figures were reported.

In 1992 President Mugabe of Zimbabwe brought Presidents Masire of Botswana and Nujoma of Namibia together in a mediation effort, where they agreed on the importance of resolving the issue and of maintaining navigation, fishing and tourist traffic. They appointed a technical committee of experts to determine the boundary line on the basis of the 1890 Anglo-German Treaty and the 1892 Anglo-Portuguese Treaty (Africa Research Bulletin, 1996:12147).

From 1992 to 1995 there was a general lull in activities related to the dispute.

The two states came together in a summit that was held in Harare, Zimbabwe during February 1995. The joint committee appointed in 1992 submitted its report at this meeting. President Mugabe of Zimbabwe announced on February 15, 1995 that Namibia and Botswana had failed to reach agreement in the dispute, and had decided to place the matter before the International Court of Justice (ICJ) for arbitration (News Digest, 1995:40394; SAPA, 15 February 1996). There is thus clear evidence that the resort to force was not a viable option at this early stage in the dispute. President Mugabe noted after the meeting that, "regrettably, the report of experts reflects a difference of opinion, and it was resolved that both countries should prepare their cases for the International Court". President Masire noted that the Botswana view was that the original treaty had placed the border at the deepest part of the river, and as the river channel had now moved, the island belongs to Botswana. The Namibian position was that the island had always belonged to South West Africa when it was a German colony. Furthermore the island had always been regarded by local Namibian inhabitants in Caprivi as an integral part of the territory on which they could hunt, fish, plough and graze their cattle without interference. President Nujoma thus dismissed as "irrelevant", the contention by Botswana that the main river channel had moved since the 1890 Treaty, to such an extent that it no longer flows south of the island. President Nujoma claimed that even if this was true, then the borderline had still been fixed in 1890 (Africa Research Bulletin, 1996:12147). Both Presidents Masire and Nujoma agreed to submit the dispute to the ICJ for a "final and binding determination" of the border between the two states around the Kasikili-Sedudu Island. The court's decision would thus be binding on both countries (SAPA, 6 June 1996 at 1545 GMT).

While both the governments of Botswana and Namibia committed themselves in advance to the outcome of the ICJ ruling, this decision failed to defuse the controversy

(Africa Research Bulletin, 1996:12147). Foreign Ministry sources consulted said that it was rumoured within diplomatic circles at this time that officials within Botswana blamed President Mugabe for the poor handling of the mediation efforts. Within Botswana, Lt-General Ian Khama allegedly blamed President Masire for his mismanagement of the crisis, by failing to allow President Mugabe to prevent the dispute being referred to the ICJ. In this regard, the outstanding trade dispute between Botswana and Zimbabwe was seen to have made President Masire vulnerable to President Mugabe.

Delegations from both the governments of Namibia and Botswana met in Windhoek on 23 November 1995 to draft the legal framework for submission to the ICJ. The different media took varying stances on the event. One newspaper described the meeting as a "civilised stand-off" (Windhoek Advertiser, 24 November 1995). Another Namibian newspaper accused the government of Botswana of attempting to impose a news blackout on the developments surrounding the dispute. The Republikein newspaper went so far as to quote Dr. Albert Kawana of Botswana, who allegedly accused the Namibian media of being "unnecessarily inquisitive" in this regard (Republikein, 24 November 1995). Yet another report noted that both the governments of Namibia and Botswana decided to impose a media blackout on the ongoing Kasikili-Sedudu dispute (Namibian, 24 November 1995). Of significance, the Namibian media recorded that members of the Namibian government were quoted as being dedicated to the peaceful resolution of the Kasikili-Sedudu Island dispute (Windhoek Advertiser, 24 November 1995).

At about the same time, it was rumoured that the Namibian government was considering approaching South Africa, to ask if President Mandela could mediate, after the failure of the Mugabe initiative. This was not confirmed however anywhere in the media or by Foreign Ministry sources consulted.

It was reported (Southscan, undated:a) that Namibia was trying to enlist the support of Angola in the resolution of the Kasikili-Sedudu Island dispute. The BDF had despatched a platoon to the disputed island after unknown persons had fired shots at BDF soldiers on 20 February. Officials from Botswana denied reports, which were circulating within the media in Namibia, that Botswana had diverted the Chobe River away from Namibia (Southscan, undated:a). The issue thus began to take on a dimension that was indicative that it was more than a mere border dispute, but that it involved access to the flow of water as well.

The diversion claims made by Namibia against Botswana are unsubstantiated and can be linked to natural fluvial dynamics. An island is not a permanent feature in the natural life of a river, especially where it traverses the flat featureless landscape that is characteristic of the area. This aspect has been described by Davies (1996a) regarding the fluvial morphology of the lower Zambezi River. Older rivers do meander over time and natural sedimentation processes cause channels to silt up and islands to become consolidated. The only permanent feature of the island is that it can be remembered as having been a certain way in the living memory of an individual human being. It is thus considered to be permanent by people, whereas in reality its existence is part of a long, slow evolutionary process spanning a considerable length of time. Thus the perceptions of the individual regarding an armed build-up by Botswana, became linked by the observer to a visible low-flow condition, where the southern channel of the island became consolidated with the bank. The erroneous conclusion was thus drawn that the river must have been diverted as part of a hostile plan. The fact that the island was shown on a map from the early part of this century is therefore irrelevant. All that the map did was record the existence of the island at that specific moment in time.

Botswana and Namibia signed an agreement on 15 February 1996, to accept the decision of arbitrators at the ICJ. The agreement was signed by Botswana's Permanent Secretary in the Ministry of Presidential Affairs, Molosiwa Selepeng and Namibia's Permanent Secretary of Justice, Albert Kawana. At a press conference Selepeng recalled that a year ago, Presidents Masire and Nujoma agreed at a Summit in Harare, to have the dispute referred to the ICJ. Selepeng added that the current agreement indicated the willingness by Botswana to accept the final ruling of the ICJ (SAPA, 15 February 1996).

In March 1996, the Namibian government ratified the agreement to take the Kasikili-Sedudu Island dispute to the ICJ. Ian Brownlie, an expert on international law and African borders, was to lead Botswana's team. Brownlie was involved in the first attempt to reach an agreement with Namibia over the dispute in 1992. Mr Kedikilwe of Botswana announced that the cost of the previous legal work was P1,3 million (Economist Intelligence Unit, 1996e:7). Theo-Ben Gurirab, the Namibian Foreign Minister, urged Botswana to remove its troops and national flag from the island, pending a decision from the ICJ (Africa Research Bulletin, 1996:12147).

Foreign Ministry sources consulted noted that Namibian officials were of the opinion that Botswana had beefed up its military capacity for possible intervention in the event of an unfavourable ICJ ruling. Botswana officially protested to Namibia, saying that since the agreement of 15 February 1996, Namibia had persistently continued to address the matter in the media by accusing Botswana of a military build-up over the island dispute. This sentiment was echoed by the Namibian Deputy Minister of Agriculture and Water Affairs during a personal interview that was conducted by the author (Webster, 1996).

Foreign ministry sources consulted noted that the DTA, a Namibian political party, claimed in June 1996 that the Botswana military build-up was aimed at taking over the Kasikili-Sedudu Island "and the whole of the Caprivi Strip", which was historically part of Botswana. The DTA expressed the fear that if the ICJ ruling went against Botswana, then the military build-up may lead to war. The DTA called for a seizure of the island in this eventuality. There is thus evidence at this stage in the dispute of local political parties beginning to mobilise public opinion around the issue, possibly in an effort to increase their support base in the agriculturally viable Caprivi Strip. Significantly this is the area within the otherwise extremely arid Namibia that is water rich, being traversed by the Kavango, Cuando (known locally as the Chobe/Linyati) and Zambezi Rivers.

The commander of the Botswana Defence Force (BDF), Lt-General Seretse Khama Ian Khama, said that Botswana believed in the peaceful resolution of disputes with reference to the disputed Kasikili-Sedudu Island, when addressing a group of journalists in Kasane. He went on to say that Botswana did not see Namibia as a threat, and that there were no hostile intentions towards that state. The media in Namibia had recently made claims that BDF soldiers were concentrated around the Kasikili-Sedudu Island. Gen. Khama said that these allegations were unjustified, as the nearest BDF troops were 320-km away (Radio Botswana, 13 May 1996 at 1610 GMT). Lt-General Khama also said that poachers were using sophisticated weapons, which needed to be countered. The Dutch government had made uniforms and equipment available at favourable prices, and the USA had made boats available for patrolling the Okavango Swamps. The German government had given the BDF strike and logistic equipment (Radio Botswana, 13 May 1996 at 1910 GMT). Khama claimed that BDF soldiers patrol the area as part of an anti-poaching effort. Louis Selepeng, the Permanent Secretary for Political Affairs in Botswana, confirmed that the flag had been hoisted on the disputed island in order to warn poachers that they were committing illegal acts on Botswana soil (Africa Research Bulletin, 1996:12147).

The Kasikili-Sedudu dispute was submitted to the ICJ on 6 June 1996. Namibia budgeted US$ 1,8 million for the legal fees, but it was noted that this could escalate to

US$ 18 million as the Namibian government was intent on hiring highly paid American lawyers to fight their case (Vines, 1996:6).

Each government was required to submit memoranda to the ICJ by 27 February 1997, and on 28 November 1997 each state was given a chance to submit counter-memoranda. The actual hearing is likely to take place in May or June 1998 and is expected to take ten days to finish. The final outcome is thus no known at the time of writing.

Meanwhile Foreign Ministry sources consulted said that it was being rumoured that the NDF had deployed a battalion at Mpacha in response to the active patrolling by the BDF near Katima Mulilo. The BDF was being deployed in the Ngamiland area to prevent the movement of cattle, as farmers were moving their animals away in response to the government attempts to slaughter them, in order to eradicate cattle lung disease (Southscan, undated:d).

Botswana confirmed, via the Botswana High Commissioner in Windhoek, that it had deployed troops near the disputed Kasikili-Sedudu Island in the Chobe/Linyati River, but said that this was part of an operation to destroy 300 000 head of cattle that were infected with bovine lung sickness. In response to this, Theo-Ben Gurirab said that it was up to the NDF to ascertain whether this was the real reason for the troop build-up near Kasikili-Sedudu, and that if it was the intention of Botswana to entrench its position on the island through the deployment of troops, it "would have very serious consequences". The military build-up inside Botswana was reported as causing unease in Namibia, as Botswana had little internal instability and there were no signs of a regional threat (Southscan, undated:e).

Namibia expressed concerns over the general military build-up by Botswana. Theo-Ben Gurirab accused Botswana of strengthening its military presence in the disputed area of Kasikili-Sedudu. Lt-General Khama replied that the BDF were in the area to enforce a campaign to counter the outbreak of lung disease in cattle. Mr Gurirab was not satisfied with this reply and called the purchase of "heavy weaponry provocative and unnecessary" (Economist Intelligence Unit, 1996e:7). In addition to this, the Botswana airbase was reported to be causing concerns in the Southern African region, as it appears to be too large for Botswana's own needs (Southscan, undated:b).

The SADC Protocol on Shared Watercourse Systems was reported as having failed to settle the dispute. Dr. Charles Hove, the principle economist of SADC, opposed the move to place the issue before the ICJ, as it was inconsistent with the SADC Water Protocol (Africa Research Bulletin, 1996:12147).

On three occasions since April 1996, Namibia accused Botswana of a military build-up over the ownership of the disputed island. In 1996 there was an outbreak of Contagious Bovine Pleru-Pneumonia in the Ngamiland area surrounding the Okavango Swamps. The Botswana government in turn, claimed that the army was being used to control the outbreak of Contagious Bovine Pleru-Pneumonia. This was threatening Botswana's export of 13 000 tonnes of beef to Europe, which is worth about US$ 45 million a year (Vines, 1996:6). Because this was a threat to the Botswana cattle industry, which is a major earner of foreign currency, a government decision was taken to eradicate the disease. As this meant the ruthless culling of some 300 000 animals, the local farmers decided to move their cattle across the border and thus protect their livelihoods in the manner that they perceived to be the most appropriate. In order to prevent this, the BDF deployed troops in the area. Namibia misinterpreted this action as being hostile, indicating the role that perceptions play in this regard.

At this stage the media suddenly focused on an issue, that until then had been completely separate. It was reported that the plans by Namibia to abstract water from the Kavango River, caused the government of Botswana "grave concern", coming in the wake of the dispute over the Kasikili-Sedudu Island. Observers noted that the plans by Botswana to increase the strength of the Airforce, and the attempted purchase of 50 tanks from the Netherlands, "do not seem so absurd as originally thought". There were thus two issues straining relations between Namibia and Botswana at that time - the Kasikili-Sedudu Island dispute; and the abstraction plans by Namibia for water of the Kavango River (Pretoria News, 1 October 1996). From this moment on the two issues became linked.

Namibia threatened to appeal to the ICJ if Botswana opposed the planned abstraction of water from the Kavango River. Relations between the two states were reported as being, "strained with the ICJ considering a dispute over the tiny island of Sedudu on the Zambezi". The animosity increased in 1996 when Namibia announced plans to abstract 20 million m^3 / yr^{-1} from the Kavango River. This level of abstraction was planned to triple by the year 2003. A 250-km pipeline is being developed that will link the Okavango to Grootfontein, where it will join the existing link to Windhoek provided by the ENWC. Namibia was reported as being, "determined to go ahead with the pipeline", threatening to take the matter to the ICJ for a ruling on their legal riparian abstraction rights if necessary. Significantly Botswana backed down from a similar project five years previously due to pressure from environmentalists (Electronic Mail & Guardian, 28 January 1997).

A USA based company, Owens Corning, met senior Namibian officials and expressed an interest in supplying piping made from fibreglass to build the 250-km final section of the ENWC, which will divert water from the Kavango River. The pipeline had the design capacity to abstract 700 litres of water / s^{-1} from the Kavango River. The piping would be manufactured locally in a purpose built factory, if the transaction was agreed upon. In response to this, Tawana Moremi, the Paramount Chief in the Okavango Delta of Botswana said, "I don't like this pipeline very much. We should buy more planes and bomb it". Piet Heyns, of the Namibian Department of Water Affairs was quoted as having said, "there has been a suggestion that Botswana want to buy tanks to shoot at the Namibians because they want to steal water from the Okavango. This is nonsense, the two things are not connected" (Weekly Mail & Guardian, 29 November 1996).

Namibia defended the plans to abstract 20 million m^3 / yr^{-1} from the Kavango River despite protests from environmentalists. Richard Fry, Deputy Permanent Secretary of the Namibian Department of Water Affairs, said that the severity of Namibia's water crisis left it little option. The dams supplying Windhoek were at 9% of capacity at that time, which was an all time record low. In the interim, Namibia began pumping water from an abandoned mine south of Grootfontein, which was expected to see Windhoek through the next 12 months even if no rain fell and the dams dried up. The Namibian argument that the abstraction of Kavango water will be "negligible" was not widely accepted in Botswana, where recent newspaper headlines proclaimed that, "Green activists might take up arms" in response. Fry was quoted as being of the opinion that Botswana would ultimately see Namibia's crisis in the light of "humanitarian need" and would thus ultimately respond positively to the proposed pipeline (Weekly Mail & Guardian, 6 December 1996).

The build-up to the ICJ case was treated by the Namibian press as a "war of words", while the Botswana press was reported as being "laid-back" over the affair (Economist Intelligence Unit, 1996e:7). Interestingly enough, the posture of Namibia, especially that evident in the media, is indicative of the generally weak riparian position that it finds itself in. On the Kavango River, Namibia is a low order riparian in relation to Angola, but a higher order upstream riparian in relation to Botswana. The advantage of this higher order riparian status cannot be effectively translated into hydropolitical advantage for three main reasons. Firstly, the Okavango system is regarded as being highly ecologically sensitive. As such it is protected by high-powered international pressure groups. This makes it difficult to develop the resource. Secondly, regarding the overall physical geography of Namibia, the Kavango, Cuando/Chobe/Linyati and Zambezi Rivers are all located along the Caprivi Strip. This is far from the major population centres where the resource need is acute. Thirdly, river frontage on each of these systems is relatively short. This fact, coupled with the generally unfavourable engineering parameters that prevail along the limited river frontage, mean that the development of these resources is problematic.

Thus being generally a lower order riparian, or where it has a higher order status, being unable to translate this into advantage, means that Namibia is absolutely dependent on the will of other riparians to co-operate. Significantly the Kasikili-Sedudu dispute is centred in the one area of Namibia that has a large and reliable supply of water. The stakes are therefore very high for Namibia. Botswana on the other hand is also a lower order riparian state, but has a stronger *rapport de forces* position. Botswana therefore has less need to posture in the media. Botswana has also learned the valuable lesson that the international environmentalist lobby is of major importance when it comes to ecologically unsound policies. This is a lesson that is evidently yet to be learned by Namibia.

It was reported that the Namibian government, encouraged by certain foreign commercial interests, persisted in its plan to abstract water from the Kavango River. Unnamed Botswana officials are quoted as feeling that "a military response may at some stage become the only option still open" (SAPA, 25 January 1997)

Good rains fell in Namibia, which was reported to have ended the ten-year drought that was the "worst this century". The Hardap Dam was reported to be 99% full and sluices had been opened for "the first time in ten years". The Daan and Tilla Villa Dams at Gobabis were reported to be 100% full, and the Oanob Dam at Rehohoth was reported to be overflowing. The Omatako Dam was reported to be more than half full, with the Swakoppoort and Von Bach Dams rising. Piet Heyns, of the Namibian Department of Water Affairs, said that Namibia could "drop its plans to divert water from the Kavango River because of the good rains" (SAPA, 25 January 1997).

Moremi Sekwale, the head of the Botswana delegation to OKACOM, suggested that Namibia should raise the water tariff to help reduce demand. He noted that Botswana, with the same sized population as Namibia, consumed only half the volume of water. Sekwale said that OKACOM could not "stop Namibia from drawing water from the

Okavango" according to the 1994 OKACOM Agreement. Construction of the 250-km long pipeline was scheduled to commence in October 1997 and would take one year to complete. The Chinese government pledged US$ 283 000 towards the pipeline project. In 1993 Botswana was forced to scrap similar plans after an independent environmental impact assessment conducted by the International Union for the Conservation of Nature (IUCN) had revealed that better alternatives existed (World Rivers Review, February 1997).

Foreign Ministry sources consulted said that the SADC Organ for Politics, Defence and Security will probably not involve itself with the dispute as it now stands, as they will wait for the ICJ ruling, but they may be forced to intervene if the matter continues to escalate afterwards. The same sources noted that there had been mention made of the fact that perceptions existed that the BDF was busy formulating its own Foreign Policy, which was somewhat different to that of the official government policy.

Botswana Military Build-up during the Dispute

There was a reasonable arms build-up in Botswana before and during the Kasikili-Sedudu dispute. The following gives an indication of the magnitude of this build-up.

It was reported that Botswana was granted American military aid to the value of US$ 4,3 million for the purchase of 10 surveillance aircraft and 15 air-boats for BDF anti-poaching efforts (Southscan, undated:d). Israel reported the delivery to Botswana of 4 armoured combat vehicles (Vines, 1996:7). The USA offered Botswana two surplus C-130 cargo aircraft (Southscan, undated:d) for delivery on an undisclosed date in the future.

In 1995 Botswana awarded contracts to Sweden and the Ukraine to supply military equipment. Botswana also signed an agreement on the purchase of 50 used Leopard tanks, light guns and 200 troop carriers from the Netherlands (Vines, 1996:6) at this time. The ultra-modern Bephatshwa airbase was officially opened in August 1995 to cater for the expansion of the Botswana Airforce (Vines, 1996:6).

The Botswana Minister of Finance, Festus Mogae, visited China in June 1996 where weapons purchases were discussed. In June 1996 Lt-General Khama travelled to the USA as a guest of the Pentagon where defence equipment factories were visited. The BDF is known to have received a US$ 450 000 grant for training BDF officers in the USA. Botswana intended purchasing 13 CF-5 fighter aircraft from Canada for US$ 49 million (Vines, 1996:6).

Germany's decision to veto the sale of 31 Leopard tanks to Botswana on 22 July 1996 overshadowed the first day of the visit to Botswana by the German Foreign Minister, Klaus Kinkel. The Botswana Foreign Minister, Lt-General Mompati Merafhe, told journalists that his government was "very disappointed" and "deeply regretted" the German position on the Leopard tanks that had been recently ordered from the Dutch government at a cost of about US$ 750 000. He said that Botswana needed these tanks and would look for other sources of the required weaponry. Kinkel defended the German position by saying that the Leopard tanks had originated in Germany, and a German-Dutch agreement stipulated that they should not be passed on to third countries. Kinkel confirmed that Namibia had tried to stop the arms export, but that the German decision had been taken on principle, and was not directed against the government of Botswana (SAPA, 22 July 1996 at 1731 GMT). Klaus Kinkel described the Southern African region as tense, and he said that Germany would not sell any arms to states in that region. The South African Minister of Defence, Joe Modise, had called for an arms build-up in the region (Southscan, undated:c) which may have prompted Kinkel's stance.

The British arms firm Vickers approached the Botswana government after the German veto of the purchase of the Leopard tanks from the Netherlands, offering to supply substitute tanks. According to the London based International Institute for Strategic Studies, the BDF was awaiting delivery of 36 Scorpion light tanks from Britain (Vines, 1996:6). Lt-General Mompati Merafhe said that it was regrettable that Namibia was interfering in the internal affairs of Botswana by questioning the purchase of military equipment (SAPA, 22 July 1996 at 1910 GMT). President Masire said that Botswana did not intend to discuss the purchase of military hardware by Botswana with Namibia, which opposed the transaction. These remarks were made a day after Kinkel announced that Germany had blocked the sale of the 50 German made tanks to Botswana by the Netherlands (Radio Botswana, 23 July 1996 at 1110 GMT).

The International Institute for Strategic Studies estimates that the total BDF spending increased from P415 million (US$ 171 million) in 1993 to P625 million in 1995. The total reported strength of the BDF was 10 000. The Weekly Mail and Guardian quoted the build-up in the BDF as being there for the protection of Botswana from the instability of South Africa. This was hastily denied by President Masire who claimed that the head of the BDF had been misquoted in this regard (Economist Intelligence Unit, 1996e:9; Southscan, undated:e).

The Botswana military build-up was reported to include a US$ 2 billion airforce base, which has been dubbed the "Eagle Project" because of the high level of American spending. It was reported that the American interest was based on the rapid political changes in the Southern African region. The Americans were reported to be "worried at the time about the ANC's connections with the SACP" (Rakabane, 1997). The BDF had purchased 36 Scorpion tanks from Britain at an undisclosed cost, and a number of CF-5 fighter-bombers from Canada at a cost of US$ 49 million (Rakabane, 1997).

The recent expansion of the BDF is thus seen as part of a doctrine that was based on a prevailing threat perception, and the use of the Kasikili-Sedudu Island dispute was a convenient excuse to push through additional increases in defence spending (Vines, 1996:7). It also seems plausible that Botswana's interest in the disputed island may partly arise out of wanting greater access to water resources than the island itself. Both the Botswana and Namibia military officials have used the dispute to expand their armed forces. Botswana military spending has increased by more than 200% since 1992 and the troop strength of the BDF has risen from 7 500 to 10 000 (Vines, 1996:6).

Namibian Military Build-up during the Dispute

The Namibian Defence Force (NDF) was also expanding at this time. Namibia was seeking to boost its own military power with Russian arms purchases saying that it was left little hardware after the withdrawal of South Africa (Southscan, undated:d). In the past it had received British and American training, but it signed a military co-operation agreement with Russia that would assist the NDF with both training and hardware. Sergey Svechnikov, the Chairman of Russia's State Committee on Technical-Military Policy, told journalists on 30 May 1996, after the signing of a joint military co-operation agreement, that the agreement reached with the NDF would increase the combat readiness of the NDF while supporting the military industrial complex (Vines, 1996:7). Fighter aircraft for the NDF air wing were the first priority.

Namibian Foreign Affairs spokesman, Che Kmati, accused Botswana of provoking a Southern African arms race with recent purchases of military hardware in response to the Botswana purchase of 13 CF-5 aircraft from Canada and 50 Leopard tanks. Kmati said that Namibia did not accept the Botswana explanation that this hardware was for anti-poaching units. The Botswana stance on the Kasikili-Sedudu Island was quoted as having "provoked Namibia into signing a military co-operation agreement with Russia" (Rakabane, 1997). The Russian agreement followed after the April visit to Russia by

Philemon Malima of Namibia. In the meantime, Germany was reported as having a "special" relationship with its former colony, Namibia (Southscan, undated:d).

Western diplomats were quoted as being "unhappy at Russia's success in translating pre-independence links with the ruling SWAPO party into a formal bilateral pact". Western diplomats feared that this agreement might "presage a confrontation with Botswana" over the Kasikili-Sedudu Island. Theo-Ben Gurirab warned against "war fever", but the media noted that, "Russian military assistance could prove vital should diplomacy fail to resolve the Kasikili dispute" (Africa Analysis, 1996:6).

Namibia also began looking elsewhere for weapons. In May 1996 President Nujoma visited China and discussed future military co-operation. During May 1996 Brazil supplied several multiple rocket launcher systems to Namibia. Nujoma then visited Spain in June 1996 where he talked about fishing and arms purchases (Vines, 1996:7).

Probable Implications of the Kasikili-Sedudu Dispute

The implications of the above are that there seems little evidence that a war over water is likely within the study area, at least at this stage. Such a war is not impossible however. While it is clearly too early to make a final assessment, given the fact that the ICJ has yet to make a ruling, all the available evidence at this stage seems to indicate that a juristic solution will be preferred above a militaristic one. In other words, a 'core value' based on legalistic solutions is evident. In reality, only a few shots were fired and the event can hardly be called a "war". No casualties have ever been reported. It is the media and political parties that are referring to the situation in terms of "war", presumably each with their own motive such as increased readership or support.

Of consequence to the current research, this case study supports the opinion of Lowi that legal riparian regimes are narrow in focus within arid regions. The inability of OKACOM to be able to intervene in the escalating Okavango portion of the dispute is clearly evident. The same can be said of the apparent failure of the SADC Water Protocol in this regard. The SADC Protocol was only adopted in 1995. It is argued that the newly established Protocol still requires some time to establish the necessary institutional capacity to deal with such matters. It can therefore not be exclusively concluded that the SADC Protocol on Shared Watercourse Systems has failed what could be described as its first real test.

The implication of a transition from a supply sided approach to a demand sided approach is also raised. As noted in the previous chapter, Botswana had made this transition (at least at the intentional level) and as such is likely to benefit from a 'virtual water' based solution whereas Namibia has not. This is evident in the statement made by Sekwale to Namibia regarding tariff structures in that country and the effect that these have on overall demand.

Lake Malawi Dispute

This dispute is less dramatic than the Kasikili-Sedudu matter. There is also less literature available as a result. The dispute is relevant for three reasons. Firstly, Malawi is the one state in the study area that has the highest projected population pressure for the year 2025 (Appendix "B"). Population pressures on resources are thus likely to play a major role in future hydropolitical dynamics. Secondly, the dispute is centred on Lake Malawi, which is located on the Shire River, an important tributary of the Zambezi River. It thus forms part of the Zambezi Basin. Thirdly, an aspect of the dispute involves a number of other neighbours, all of whom are part of the study area. As indicated in the analysis of the previous chapter, many of the states concerned are unstable.

Evolution of Events Linked to the Lake Malawi Dispute

The facts on this dispute are given by Day (1987:154-157). A summary of this follows. In an agreement concluded between Britain and Germany in 1890, the western border of what was then German East Africa was described as running along the Eastern Shore of Lake Nyasa. In 1891 Britain proclaimed a protectorate over the Nyasaland region. This became known as the British Central African Protectorate. It was renamed the Nyasaland Protectorate in 1907. In the interim the second Anglo-German agreement of 1901 merely gave formal approval to the findings of a joint boundary survey. A map is presented in Figure 18 in order to orientate the reader.

In practice the case was different however. German sovereignty extended to the median line of the lake (Nyasa) which was unchallenged until 1922. At this time the majority of what was then German East Africa became the Mandated Territory of Tanganyika, which was awarded to Britain under a League of Nations mandate. Official British sources from this period show the western border as being the median line through the lake. Tanganyika was declared a United Nations trust territory after the Second World War and Britain was again awarded trusteeship. Official British documents of this period abandoned the median line as a border and reverted back to the eastern shore of the lake in accordance with the 1890 Anglo German agreement. This border was reaffirmed when the Central African Federation of Rhodesia and Nyasaland was proclaimed in 1953.

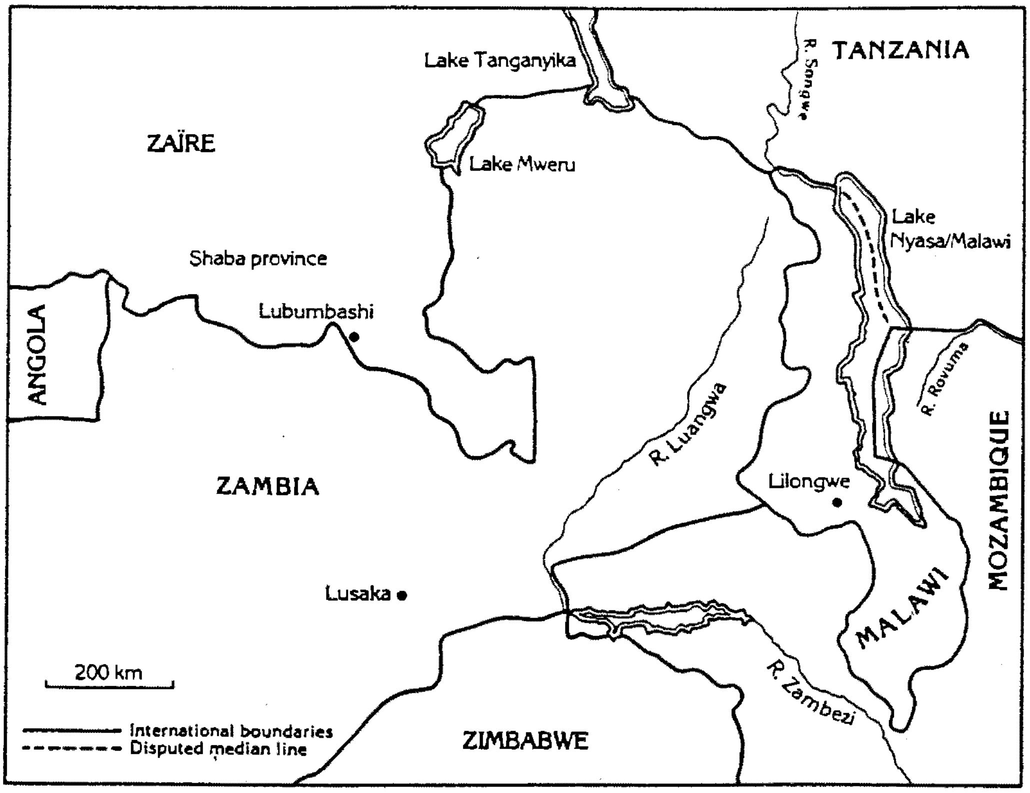


Figure 18. Map of Lake Malawi showing territorial relationship of riparians (Day, 1987:155).

When Tanzania obtained independence from Britain in 1961, it rejected the arbitrary border change that had been made by the British government. Tanzania considered itself bound by the OAU Heads of State Resolution of July 1964 that the borders of African states, as on the day of their independence, constitute a tangible reality. In 1967 the Tanzanian government raised this issue officially with the government of Malawi, stating that Tanzania wished merely to clarify the matter without wanting it to become an international issue between the two states. Tanzania noted in this communication that it had no intention of making any territorial claims beyond the median line. The Malawi government replied that this matter would receive consideration.

In 1968 President Banda addressed a Malawi Congress Party meeting and declared that the *real* boundaries of Malawi are 160-km north of the Songwe River, which is

Malawi's present northern boundary with Tanzania. In addition to this the *real* southern border of Malawi is the Zambezi River in Mozambique. To the west Malawi's *real* border is the Luangwa River in Zambia, and to the east it is the Indian Ocean. President Banda based these ambitious claims on the ancient Maravi Empire, which was shown on early Portuguese maps. Furthermore, President Banda claimed that Lake Nyasa had always belonged to Malawi and that he, as President, had every right to change the name to Lake Malawi.

This matter was discussed between President Nyerere of Tanzania and President Kaunda of Zambia on 27 September 1968, at Mbeya in Tanzania, in order to formulate a common front on the issue. The government of Tanzania later dismissed the claims made by President Banda as not being worthy of a reply. The government of Zambia responded in a similar manner. The border issue has since then remained an unresolved but dormant one between Tanzania and Malawi. There were no formal diplomatic relations between Tanzania and Malawi until 1985 however.

Probable Implications of the Lake Malawi Dispute

One major implication of the fact that the territorial claim, which was made by President Banda, was never finally resolved, is the possibility that the issue may again be raised in future. The likelihood of this becoming the case may increase given the fact that the empirical analysis of both Malawi and Tanzania in the previous chapter indicates increasing levels of water competition in both of these states. In the case of Malawi, it will be "water stressed" by the year 2000 (Position 3 on the WBS), moving beyond the "water barrier" by the year 2025 (Position 5 on the WBS). Tanzania on the other hand is likely to be facing "chronic scarcity" (Position 4 on the WBS) by the year 2025. Thus increasing competition for water in both countries is likely to intensify the struggle for access to water resources, with the highest level of need likely to be shown by Malawi. This may in turn trigger the old unresolved dispute. In this regard both Tanzania and Malawi could come into renewed conflict between themselves. Malawi may also renew the claim on the Luangwa River in Zambia as Zambia is predicted to have a lower internal conflict potential due to the more favourable WBS positions (Position 2 by the year 2025).

The capacity of most of the states involved is somewhat limited however, as the previous chapter shows. The likelihood of this becoming a major hydropolitical "hot spot" is thus small. The case study presents no evidence of the use of force to resolve the conflict.

Conclusion

From the foregoing analysis and discussion six major conclusions can be reached. These are as follows:

- There is no concrete evidence of the actual existence of a political culture within the study area that suggests the resort to force in riparian disputes to be the accepted norm.

- It can be said that there was evidence of a failure by multilateral organs that are based on a functional co-operative model to effectively intervene and end the crisis. In the case of the Kasikili-Sedudu dispute, the SADC Protocol was never resorted to, although it could be argued that the agreement between Botswana and Namibia to present the matter for ICJ arbitration was taken before the Protocol had come into full force. Similarly, the SADC Organ on Politics, Defence and Security was only established in June 1996. Prior to this, SADC was thus not equipped to deal with this type of dispute. In the case of OKACOM, there is clear evidence that it was unable to intervene. Lowi's findings in this regard are thus considered to be relevant, as there is evidence that suggests "high politics" takes precedence over "low politics" type of technical co-operation.

- There is evidence that national interest seems to prevail when it comes to resolving matters by means of functionally co-operative type of structures, rendering them impotent regarding their conflict resolving capacity. This is very tentative however as the evidence is limited.

- There is strong evidence in the Kasikili-Sedudu dispute of the propensity for the escalation of the crisis. What started out as a small border dispute, became linked to the rights of Namibia to abstract water from another river system entirely. In this regard, OKACOM failed to present a viable solution to the problem, with threats from Namibia that the matter would also be presented to the ICJ if necessary.

- There is strong evidence in the Kasikili-Sedudu case that a state has the legitimate hydropolitical need to develop sufficient storage capacity to enable it to survive through the normal cyclical drought periods in arid regions. In this regard the Okavango issue only became pertinent when the overall national water supply in Namibia became critically low.

- A clear distinction should be made between the intention of a state to commit an act of armed confrontation, and the rhetoric that is presented in the mass media. The military build-up in Botswana is a case in point. An aspect of this build-up is linked with the establishment of anti-poaching units that are being supported by international efforts to stop the illegal hunting of elephant and rhino. Significantly, the natural range of these animals is centred on the wetland system that exists around the Okavango Swamps and Caprivi Strip.

It can therefore be said that there is no evidence of an impediment to the kind of co-operation, which is needed for a 'virtual water' development strategy to succeed, in either dispute.

CHAPTER 5

RESULTANT HYDROPOLITICAL DYNAMICS

Introduction

From the previous chapters it has been shown that functional co-operative solutions are generally advocated for problems relating to shared water resources in arid regions. It has also been shown that structures, which result from these functional co-operative models, usually work only to the extent that they benefit the riparian state concerned. Thus co-operation does exist, provided there is no intrusion of "high politics" into the equation. In other words, national interest seems finally to prevail when it comes to water access in arid regions. This is a manifestation of the Realist versus Idealist dilemma first noted in Chapter 1. In addition to this, it has been established that there is a clear causal link between population growth (second subproblem) and water scarcity (first subproblem). It is the growing population that competes for access to the finite water resources, which creates the scarcity in the first place. The growing population needs to be fed so this impacts on the agricultural capacity of a state (third subproblem) by increasing the demand for the production of food staples. This in turn leads to a growing demand for water and hence increased competition between the various economic sectors, which again impacts on the overall water scarcity (first subproblem). The efficiency of a given economic sector at converting scarce water into a contribution to the economy therefore becomes relevant in arid regions. Planners essentially need to make a rational policy choice between alternate uses, which are in conflict with each other. There is a relationship between the degree of scarcity and the level of conflict potential.

Empirical evidence has been presented to support the hypothesis that the industrial sector tends to be more efficient than the agricultural sector, when it comes to converting scarce water into actual contribution to the GDP in arid regions. It can be said that this hypothesis has been partially substantiated only, as due to the problems surrounding access to accurate SWE data, this evidence exists for 1995 only. Unfortunately the data set for 1987 excluded the industrial sector, thereby preventing a direct comparison between sectors for that year. A better comparison can be made within the agricultural sector, as there were two data sets available, for 1987 and 1995. This empirical evidence does support the hypothesis that the agricultural sector is less efficient at converting scarce water into an actual contribution to the GDP.

What now needs to be accomplished is to analyse the hydropolitical dynamics that are present within the study area, in light of the empirical evidence already presented, in order to better understand the resultant political manifestation against the background of the increased water scarcity. In this way the potential of the proposed 'virtual water' development strategy can be assessed.

Identification of Key Actors

Given the data that has been presented and processed in Chapter 3, it is now possible to identify the key hydropolitical actors, or grouping of actors, within the study area.

HPRP Data Yield

The HPRP data yield was not problematic and provides clear evidence that the increased water scarcity (first subproblem) is causally linked to the population growth (second subproblem). It also shows that where the water resource availability is high, the impact of the increasing population is less than when the original resource base is low.

Criteria Used for the Categorisation of HPRP Data Yield

The criteria for the categorisation of the HPRP risk profiles were not problematic, as other researchers had previously defined them to an extent (Falkenmark, 1989:116; Arnestrand *et al.*, 1993:23). The author consequently only had a need to refine these criteria. For the convenience of the reader, the HPRP norms are reproduced below. The results of this HPRP analysis in Chapter 3 were interpreted from the WSI data as follows:

- 11 & 12 was a low HPRP
- 21, 22 & 31 was a medium HPRP
- 13, 23, 24 & 32 was a high HPRP
- 25, 33, 34 & 44 was a very high HPRP

Interpretation of Overall HPRP Data Yield

Table 70 presents a summary of the HPRP analysis from Chapter 3. From this it can be seen that there are a number of cases that have been labelled as "high risk". In all cases the high HPRP is the result of population pressure on water resources, which validates the first subproblem. Six combinations of variables could have been reached. These are:

- (A) High HPRP coupled with a weak economy
- (B) High HPRP coupled with a strong economy
- (C) Medium HPRP coupled with a weak economy
- (D) Medium HPRP coupled with a strong economy
- (E) Low HPRP coupled with a weak economy
- (F) Low HPRP coupled with a strong economy

A summary of the final HPRP data yield for all of the states in the study area is presented in Table 70.

TABLE 70

HPRP OF ZAMBEZI BASIN RIPARIANS AND SOUTH AFRICA

STATE	HPRP 1982	HPRP 2000	HPRP 2025
Angola	Low	Low	Low
Botswana	Low	Medium	Medium
Malawi	High	High	Very high
Mozambique	Low	Low	High
Namibia	Medium	High	High
South Africa	Very high (1990)	n/a	Very high
Tanzania	Low	Medium	High
Zambia	Low	Low	Low
Zimbabwe	Low	High	High

From this table, the possible combination of variables can be extracted.

"Eastern Belt of Poverty"

The high HPRP cases fall into two distinct categories, namely those with weak economies and those with strong economies. Again the issue of relativity is used here in determining weaker or stronger economies.

(A) The first category of high-risk HPRP cases consists of states that have a high HPRP in conjunction with a weak economy. The implications of this combination of variables are that the economy simply lacks the capacity to diversify, and therefore to fund the 'virtual water' importation that is necessary to balance the water budget. These cases will consequently not benefit from a 'virtual water' based development strategy, but will probably need various degrees of external assistance. A very real implication of this will be that these states have the potential to be the source of migrants, which may be attracted to other states in the study area. They thus have a potential destabilising effect within the Southern African region as a whole. These states are geographically located in the eastern portion of the study area which can be called the "Eastern Belt of Poverty" for want of a generic label. These states are:

- Malawi
- Mozambique
- Tanzania

Two of these states (Mozambique and Tanzania) are particularly revealing in hydropolitical terms. In both cases there is a unique set of circumstances that prevails.

- There is a low level of infrastructure available to these states.
- These states both have high population levels, having respectively the second and third highest total population within the study area.
- These states are relatively well off regarding the recoverable resources available, having respectively the third and fourth largest volume of water in the study area. Both have access to water from a number of other river basins that are independent of the Zambezi (Table 1) and that exist in the study area. (This is analysed in more detail later on in this chapter).

These states consequently offer the most conclusive proof that the increasing water scarcity (first subproblem) is population induced (second subproblem). Thus the potentially favourable position that was reflected in the original low-risk HPRP becomes insignificant. The potential advantage of being relatively water abundant is not translated into economic advantage because of the combination of a rapid population growth rate and other political factors (civil war, colonial experience and/or choice of development models).

The Mozambique case is extremely revealing. The HPRP profile up to the year 2000 is low, then it suddenly jumps to a high profile. This can be seen as a manifestation of the disruption that has been caused by the civil war, which caused a massive displacement of people. This in turn has increased the population growth rate while reducing the capacity of the state to provide.

The third case in the category, Malawi, is also interesting. This state presented with a combination of a high to very-high HPRP profile, coupled with a high degree of resource dependence on the Zambezi Basin. This also offers conclusive proof that the increasing water scarcity is population induced. This is expanded on later in this chapter.

"Central Belt of Resource Scarcity"

(B) The second category of high-risk HPRP cases consists of states that have a high HPRP in conjunction with a relatively stronger and more diversified economy. This economic strength is relative however. The implications of this combination are that the economy potentially has sufficient capacity to fund the 'virtual water' importation, which will enable the projected water deficits to be met in future. This will also imply that these states will have to make a paradigm shift away from a strictly supply sided management approach, to a more demand sided management approach. These states are geographically located in the centre of the study area, which can be called the "Central Belt of Resource Scarcity" for want of a generic label. This label is used, as although the states are economically diversified, future economic growth can be hampered by the limited availability of water. Strategic access to water can thus be seen as a potentially key component of the national interest in future. This implies that water is likely to become increasingly politicised in these states, especially during years of drought. These states can therefore be regarded as the major hydropolitical actors in the study area, as their demand for strategic access to water is likely to increasingly impact on other actors and thereby provide the driving force. These states are:

- South Africa
- Zimbabwe

An additional point can be made regarding these two states in terms of Lowi's theory of hegemonic co-operation. Depending on the unit of analysis that is chosen, either of these states can be regarded as a hegemon. The unit of analysis that has been used in the current study is that of the Zambezi Basin *and* South Africa. In terms of this unit of analysis, South Africa can be regarded as the hegemon. This in turn means that South Africa can be expected to take the leading role when it comes to regime creation and enforcement. There is evidence that this is taking place as the White Paper on Water Policy commits South Africa to playing an active role in developing international law regarding shared river basins (DWAF, 1997:6.9.2). This unit of analysis is somewhat artificial however, and was chosen deliberately in order to understand what the likely hydropolitical dynamics would be in this given configuration. This was done because it was originally postulated that South Africa had the greatest need for access to water within the entire study area, and may thus seek to gain access to basins where it is not a legal riparian. This unit of analysis is thus seen to be valid, at least for a scientific investigation.

An equally compelling argument could be made that the unit of analysis should be the Zambezi Basin riparian states only. If this were chosen as the unit of analysis, then the hegemon would be Zimbabwe. In this case, one would expect Zimbabwe to take the lead in regime creation and enforcement. There is strong empirical evidence of this. At the Second Southern Africa Water and Wastewater Conference that was held in Harare from 15-18 September 1997, the Minister of Rural Resources and Water Development gave the keynote address. This was immediately followed by a presentation by Mr. Tumbare, the Chief Executive Officer of the Zambezi River Authority (ZRA). This paper (Tumbare, 1997) can be seen as the "master plan" by Zimbabwe to create a basin-wide regime for the Zambezi Basin. This paper refers to the SADC Protocol on Shared Watercourse Systems, and then seeks to present the details of a regime that is in keeping with the requirements of the Protocol. A case is made out for the expansion of the ZRA into a basin-wide structure. The significance of this sentiment is that the ZRA exists at present between Zimbabwe and Zambia, and has the function of managing the Kariba Dam. If Lowi's theory is applied, then it becomes relevant that the hegemonic power in the current ZRA (Zimbabwe) is taking the lead in creating a regime for the entire basin, because Zimbabwe would arguably benefit the most from this. The important point to note is that South Africa is not included in this configuration. Zimbabwe, as the hegemonic Zambezi riparian state, is likely to argue that because South Africa is not a legal riparian, it should be excluded from the basin. This makes the nature of the hydropolitical dynamics that exists between South Africa and Zimbabwe inherently conflictual.

This is offered as an argument in support of the conclusion that these two states are likely to emerge as the major hydropolitical players in the study area on the demand side of the hydropolitical equation. The strategies of each are likely to differ however. Zimbabwe, as a legal Zambezi riparian state, is likely to take the lead in creating the regime and excluding South Africa. South Africa, on the other hand, is likely to use

SADC and other political fora to lobby for support for its possible actions. To this end it is interesting to observe Minister Kader Asmal who is using UN bodies more effectively than Zimbabwe is. This theme will be expanded upon later in this chapter.

(C) There are no medium risk HPRP cases coupled with a weak economy.

(D) The medium risk HPRP cases that have relatively strong economies offer an interesting set of hydropolitical variables. These states:

- are extremely arid in nature and are drought prone in the "normal" course of hydrological affairs
- have a limited availability of surface water coupled with a high resource need
- have a low population base which results in a fairly favourable HPRP under conditions where a worse scenario would be anticipated
- have a reasonably sound economy and are not generally plagued by a high foreign debt burden
- all show progressively worsening HPRP profiles (low - medium and medium - high)

The medium risk HPRP cases are geographically located in the centre and south west of the study area, but are close enough to, and share enough characteristics with, the so called "Central Belt of Resource Scarcity", to be classified under this generic heading. These states are:

- Botswana
- Namibia

The low foreign debt burden of Namibia is an important consideration for assigning it to this category.

"Western Belt of Resource Abundance"

(E) There are two broad categories that present with a low HPRP and a weak economy. The first category of these are states that present with a persistently low HPRP and which have a specific set of conditions that assigns them to this category.

- They have a high degree of water resource availability, the majority of which has not yet been translated into economic capacity in one form or another.
- They have a high agricultural potential, the full magnitude of which has never been fully realised for a variety of reasons that are beyond the scope of this study.
- They are generally economically weak and vulnerable but the causes of this weakness vary.

Geographically these states are located in the north and west of the study area, so in keeping with the nomenclature already adopted, this can be called the "Western Belt of Resource Abundance". These states are:

- Angola
- Zambia

The second category are those states that present with a low HPRP for 1982 and which could be included here, but which subsequently become high-risk HPRP cases, thereby disqualifying them from this category. These states are Mozambique and Tanzania and were previously discussed under the category "Eastern Belt of Poverty".

(F) There are no cases that present with a combination of a low HPRP and a strong economy.

Thus the HPRP analysis has enabled a degree of categorisation to be made in terms of the Methodology Flow Chart in Appendix "A". This now needs to be refined in terms of the methodology by factoring in the SWE data yield.

SWE Data Yield

Additional insight into this generic categorisation of states within the study area can be obtained by referring to the results of the SWE analysis completed in Chapter 3. Before this is done, a few points need to be noted with respect to the criteria for allocation to a SWE category of Low, Medium or High. As noted in the discussion on the research design and methodology in the Introduction, there have been no studies done in the past that have used these concepts. Consequently, there is no external reference to norms that could have been used. For this reason, there had to be somewhat of an arbitrary allocation of the criteria. The author feels that these concepts have potential value for a hydropolitical discourse and should not be prematurely discarded. Therefore, in keeping with the requirements of absolute scientific objectivity, it must be said that the data yield was anomalous in certain cases. Where this has happened, it is reported as such. Before judging the concepts too hastily, and possibly discarding them as inadequate, three points must be noted.

- The criteria were arbitrarily selected as a point of departure. Thus the author made a decision when the research design was being prepared, that the norms which were presented in the discussion on the research design and methodology in the Introduction would be used. These have been rigidly and consistently applied. The norms can be reconsidered if any additional research is conducted by using this methodology in future. If this should be done, then the current data yield may be of value to other researchers in streamlining their criteria. At this time the norms will not be adjusted however.

- In certain cases a state presented with a SWE for a given sector that was close to the limit of a norm. This was not considered to be sufficient reason to allocate it to another category, even though such reallocation would have resulted in a more harmonious interpretation. The results presented here are thus as they were rigidly determined by means of the original norms.

- In certain cases the two data sets used tended to confirm each other. This is encouraging and indicates that the concepts have a useful place as hydropolitical indicators. In other cases however, the two data sets were so incompatible as to render the result meaningless. Where this has happened, it is not the fault of the SWE as a concept, but rather the fault of the scanty data used. Unfortunately there was simply no better data available, or else it would have been used.

For these reasons, the author considers the SWE concept to be an extremely useful hydropolitical indicator, because it enables an understanding of the economic contribution of each sector in arid states, but he concedes that the results in certain cases render the ultimate conclusions as being tentative.

To this end it is encouraging to note, that the principles on which the SWE as a concept is based, are recognised in the White Paper on Water Policy (DWAF, 1997).

> For example, paragraph 2.1.8 states that, "the reallocation of existing water uses - to improve the optimum and equitable use of water - is, therefore,

constitutionally valid". Paragraph 4.1.4 states that, "what is of concern to most South Africans, and thus to the Government that they elected, is the way in which water is allocated and used should bring maximum benefit to them, whether directly or indirectly. This must become the focus of water policy". Paragraph 4.2.1 states that, "in legal terms, the best use in these circumstances is called use which is beneficial in the public interest or, more plainly, the optimum or best possible use. ... The idea of optimum use weighs up different social, economic and environmental objectives and the practicality of their achievement in order to enable authorities to make the best decisions on water use". Paragraph 5.1.2 states that, "in its role of guardian of our nation's water resources, national Government will keep the right to influence the country's economic and social benefit - for the benefit of present and future generations - through the responsibility of determining the proper use of the nation's water resources. In allocating water in the public interest, national Government must consider the planning and development of water resources in a manner which ensures the efficient, equitable and sustainable use of the resources".

Criteria Used for the Categorisation of SWE Data Yield

For the convenience of the reader, the norms are reproduced here from the discussion on the research design and methodology in the Introduction.

Interpretation of the agricultural SWE focused on the consumption side of the equation and was done as follows:

- If <50% of the consumption contributes up to 50% of the GDP it was regarded as relatively high efficiency
- If 50%-75% of the consumption contributes up to 50% of the GDP it was regarded as medium efficiency
- If >75% of the consumption produces up to 50% of the GDP it was regarded as relatively low efficiency

Interpretation of the industrial SWE focused on the contribution to the GDP side of the equation and was done as follows:

- 0-25% of the contribution to GDP was regarded as relatively low efficiency
- 26-50% of the contribution to the GDP was regarded as medium efficiency
- >50% of the contribution to the GDP was regarded as relatively high efficiency

Interpretation of Overall SWE Data Yield

The SWE results that were yielded from the analysis in Chapter 3 are presented in Table 71.

TABLE 71

SWE POSITIONS OF ZAMBEZI BASIN RIPARIANS AND SOUTH AFRICA

STATE	AGRICULTURE SWE		INDUSTRY SWE		RESULT
	1987	1995	1987	1995	
Angola	Low	Low	Medium	High	Fair
Botswana	Low	High	High	Medium	Anomaly
Malawi	High	Low	Low	Low	Fair
Mozambique	Medium	Low	Low	Low	Fair
Namibia	Low	Medium	Medium	Medium	Fair
South Africa	Medium (1990)	Medium	Medium (1990)	Medium	Good
Tanzania	Medium	Low	Low	Low	Fair
Zambia	High	Low	High	High	Fair
Zimbabwe	Low	Low	Medium	Medium	Good

The result is considered to be:

- good if there is a clear pattern evident with no variation within either sector between the two data sets used
- fair if one of the possible four results is out of sequence with the other result in the same sector
- anomalous if there is no discernible pattern

From Table 71 it can be seen that three broad categories of cases are evident if one considers the result of the data yield. These are as follows:

- There was a good yield for two states (South Africa and Zimbabwe).
- There was a fair yield for six states (Angola, Malawi, Mozambique, Namibia, Tanzania and Zambia).
- There was anomaly with only one state (Botswana).

This means that only a tentative interpretation can be made of the original results. The original criteria for the SWE norms were arbitrarily determined, and were designed to illustrate the efficiency of a given sector on a linear scale of low, medium and high. This has clearly not yielded the desired result.

However, the research effort can be salvaged if the linear scale is seen in terms of two extremes only. If this is done, then one can consider the relative position on a linear scale, with the cut-off being the middle or medium condition. In other words, if the data yield is again viewed by assigning positions relative to the middle, then a new set of potential groupings emerge.

- The relative position is assigned to the lower end of the scale if the result of one SWE yield is low and one is medium.
- The relative position is assigned to the higher end of the scale if the result of the one SWE yield is medium and the other one is high.
- If the relative position cannot be determined because of an anomaly, or because both fall out as a medium, then the relative position will be deduced with reference to the *balance of probability* by referring to other factors such as resource need / dependence, WBS data etc.

This enables a number of distinct sets of combinations to be determined. Five of the possible combinations of variables are considered to be relevant. These consist of the following combinations:

- (A) *Relatively* low agricultural SWE and a *relatively* high industrial SWE.
- (B) *Relatively* low agricultural SWE and a *relatively* low industrial SWE.
- (C) *Relatively* high agricultural SWE and a *relatively* low industrial SWE.
- (D) *Relatively* high agricultural SWE and a *relatively* high industrial SWE.
- (E) Medium agricultural SWE and a medium industrial SWE.

(A) The first case comprises those states that have a combination of a *relatively* low agricultural SWE and a *relatively* high industrial SWE. Five states fall into this category. Three are easy to categorise, as the trend is clearly evident from the data yield. These are presented in Table 72a.

TABLE 72a

STATES THAT HAVE A COMBINATION OF A RELATIVELY LOWER AGRICULTURAL SWE AND RELATIVELY HIGHER INDUSTRIAL SWE

STATE	LOWER AGRICULTURE SWE		HIGHER INDUSTRY SWE	
	1987	1995	1987	1995
Angola	Low	Low	Medium	High
Namibia	Low	Medium	Medium	Medium
Zimbabwe	Low	Low	Medium	Medium

Two are not so easy to categorise (Botswana and Zambia). In these cases other information that is known about the states in question is used to determine the *probability* of the existence of a lower or higher agricultural SWE. The methodology presented in Appendix "A" allows for this in the sense that the final evaluation of the relative advantage / disadvantage of 'virtual water' is derived from a combination of sources. In Table 72b, the two states that have the probability of a lower agricultural SWE are presented (Botswana and Zambia).

The rationale for the adjustment of Botswana is the fact that the state is known to be extremely arid with a low level of recoverable resource. The *probability* of a higher agricultural SWE under these conditions is thus not high.

The other state that is difficult to categorise is Zambia. In this case, the *probability* of a lower agricultural SWE is assumed because the state concerned is known to have a weak commercial agricultural sector. To this end there have been attempts to entice South African farmers to Zambia to kick-start their agricultural sector. Zambia has the second highest level of water resources in the study area (Table 4a) which is spatially distributed via 4 of the major basins in Southern Africa (Table 1). Two of these basins, the Kafue and Luangwa, are sub-basins of the Zambezi. The Zaire (Congo) River is the largest in Southern Africa, and Zambia has access to 4,7% (United Nations, 1978a:5) of that resource which is significant. Zambia is geographically located in a favourable climatic zone and has a high level of recoverable water resources available, which means that is has the potential for a higher SWE, but under prevailing conditions the balance of probability dictates that it is lower.

TABLE 72b

ADJUSTED RESULT IN TERMS OF THE PROBABILITY OF A RELATIVELY LOWER AGRICULTURAL SWE AND RELATIVELY HIGHER INDUSTRIAL SWE

STATE	LOWER AGRICULTURE SWE		HIGHER INDUSTRY SWE	
	1987	1995	1987	1995
Botswana	Low	High	High	Medium
Zambia	High	Low	High	High

(B) The second case comprises those states that have a combination of a *relatively* low agricultural SWE and a *relatively* low industrial SWE. No states naturally fall into this category. Three states fall into this category (Mozambique, Tanzania and Malawi) after adjustments have been made based on the *probability* of a lower agricultural SWE existing. If other criteria are used to determine the *balance of probability*, then two distinct sub-sets of conditions can be determined. The first sub-set is based on the rationale for adjustment being the fact that these two states have a relatively favourable level of recoverable water resources available, both in terms of volume, and in terms of access to a number of major basins. In addition, the geographic location is more favourable to agriculture in general.

Mozambique has access to the fourth largest volume of water resources available in the study area (Table 4a), which is spatially distributed in six of the major basins (Table 1). Given a number of factors such as general poor condition of the existing infrastructure, fairly substantial share of the Zambezi Basin (11,4%)(United Nations, 1978a:6) and the magnitude of the volume of water available in the other basins (Table 1), Mozambique has a high resource dependence on the Zambezi Basin (the reader is referred to the analysis in Chapter 3 regarding resource need / dependence). Mozambique also has the third highest population level predicted in the study area for the year 2025 (Table 6). This is reflected in the fact that Mozambique presents with the fifth highest WBS figures in the study area (Tables 4a & 4b).

Tanzania has access to the third largest volume of recoverable water resources in the study area (Table 4a), which is spatially distributed in four of the major basins (Table

1). Two of these basins are the largest in Southern Africa (Zaire/Congo and Zambezi) while the other two (Rufiji and Kilombero) are significant in their own right. The total area of the Zambezi basin that is shared by Tanzania is 2,0% (United Nations, 1978a:6). The resource dependence on the Zambezi Basin is thus low for Tanzania (the reader is referred to the analysis in Chapter 3 regarding resource need / dependence). Tanzania has the second highest population predicted for the study area in 2025 (Table 6). This is reflected in the fact that Tanzania presents with the fourth highest WBS figures in the study area (Tables 4a & 4b).

These two states are presented in Table 73a.

TABLE 73a

ADJUSTED RESULT IN TERMS OF THE PROBABILITY OF A RELATIVELY LOWER AGRICULTURAL SWE AND RELATIVELY LOWER INDUSTRIAL SWE

STATE	LOWER AGRICULTURE SWE		LOWER INDUSTRY SWE	
	1987	1995	1987	1995
Mozambique	Medium	Low	Low	Low
Tanzania	Medium	Low	Low	Low

The second sub-set is based on the rationale for the adjustment being the existence of a lower level of recoverable resource available. Malawi fits into the category of adjusted combination of a relatively lower agricultural SWE and a relatively lower industrial SWE, but it presents with hydropolitical conditions that differ fundamentally from the other two states in this category (Mozambique and Tanzania). The rationale for this adjustment is the fact that while Malawi has a favourable geographic location for agriculture, it has a low level of recoverable water resources available. Malawi has the lowest level of resource in the entire study area (Table 4a), a position that it shares with Botswana and Namibia. In terms of the number of major basins available, Malawi has access to three (Table 1). This is misleading however, as the Shire, is a sub-basin of the Zambezi, while the Lilongwe feeds directly into Lake Malawi, which in turn feeds via the Shire River into the Zambezi River. All three are thus linked and form part of the overall Zambezi Basin. A total of 7,7% of the Zambezi Basin is shared by

Malawi (United Nations, 1978a:6) which is considered to be large. The overall water resource dependence for the Zambezi Basin is thus critical (the reader is referred to the analysis of resource need / dependence in Chapter 3). While Malawi has a relatively low population in terms of total number predicted for 2025 (Table 6), the population density is the highest in the study area, and one of the highest in Africa (Economist Intelligence Unit, 1996f:10). This is reflected in the fact that Malawi presents with the highest WBS figures in the entire study area (Tables 4a & 4b). The adjusted position for Malawi is presented in Table 73b.

TABLE 73b

ADJUSTED RESULT IN TERMS OF THE PROBABILITY OF A RELATIVELY LOWER AGRICULTURAL SWE AND RELATIVELY LOWER INDUSTRIAL SWE

STATE	LOWER AGRICULTURE SWE		LOWER INDUSTRY SWE	
	1987	1995	1987	1995
Malawi	High	Low	Low	Low

(C) The third case comprises those states that have a combination of a *relatively* high agricultural SWE and a *relatively* low industrial SWE. No states fit naturally into this category.

(D) The fourth case comprises those states that have a combination of a *relatively* high agricultural SWE and a *relatively* high industrial SWE. There is no state that naturally fits in this category.

(E) The fifth case comprises that state that has a combination of a medium agricultural SWE and a medium industrial SWE and which cannot logically be adjusted one way or the other. There is only one state in this category and it fell in naturally, without the need for adjustment. In this case three data sets were available. While there was a variation in each data set, the criteria used to determine the parameters within each category meant that ultimately these variations led to an identical conclusion. This is presented in Table 74.

TABLE 74

STATES THAT HAVE A COMBINATION OF A MEDIUM AGRICULTURAL SWE AND MEDIUM INDUSTRIAL SWE

STATE	AGRICULTURE SWE			INDUSTRY SWE		
	1980	1990	1995	1980	1990	1995
South Africa	Medium	Medium	Medium	Medium	Medium	Medium

Potential Assessment of 'Virtual Water'

Having now isolated the respective variables that have emerged from the HPRP and SWE analysis in Chapter 3, albeit with some adjustment needed in the case of the SWE data yield, attention can be given to a potential assessment of 'virtual water' as a possible solution to the overall problem that results from the increased water scarcity.

Non-Beneficial 'Virtual Water' Development Strategy

The category comprising of those states that are not likely to benefit from a 'virtual water' development strategy is made of four key hydropolitical variables. These are:

- high-risk HPRP
- weaker and undeveloped economy
- lower agricultural SWE
- lower industrial SWE

These political economies tend to be agriculturally based with a weak or poorly developed industrial capacity. The emphasis in the agricultural sector is on subsistence, with limited commercial agriculture currently being practised. The problem is that these states all have a high population growth rate. The growing population is unlikely to find sustainable employment within the given political economy. The combination of these variables can act as migration push-factors as a result. Such migration is likely to target areas within the study area that offer a better chance for access to resource flows, and hence a better chance of survival. Migratory pull-factors are therefore linked to the spatial unevenness in terms of industrial development within the study area. Where higher industrial development has taken place, there is likely to be a better chance of finding sustainable employment, whether legally or illegally. This in turn can destabilise the target countries and can lead to either group-identity or relative-deprivation conflicts. The states that present with these combinations of hydropolitical variables consist of those generically categorised as the "Eastern Belt of Poverty" and are:

- Malawi
- Mozambique
- Tanzania

These states have limited potential to benefit from a 'virtual water' based development strategy and hence present a different set of problems to other states in the study area. Consequently they have to be factored into the overall hydropolitical dynamics of Southern Africa.

Beneficial 'Virtual Water' Development Strategy

The category comprising of those states that are likely to benefit from a 'virtual water' development strategy in one form or another can now be identified.

Potential 'Virtual Water' Exporters

One category comprises those states that make them potential 'virtual water' exporters, due to the combination of specific hydropolitical variables. These are:

- low-risk HPRP as evidenced from low WSI figures
- weaker and undeveloped economy
- lower agricultural SWE
- the potential for improvement of the agricultural SWE due the combination of a favourable water resource base and unexploited arable land
- higher industrial SWE
- the potential to improve the industrial SWE

Where states present with this combination of variables, they can be regarded as potential "exporters" of 'virtual water'. The basic rationale for this is the fact that the key variable is the low-risk HPRP. This is derived from the fact that the states in question have an abundance of water as a resource. There is thus considerable development potential in this regard. The states that present with these combinations of hydropolitical variables consist of those generically categorised as the "Western Belt of Resource Abundance" and are:

- Angola
- Zambia

A word of caution needs to be sounded at this point. Zambia presented with an anomaly regarding the result of the SWE analysis for agriculture. The final result came from adjusting this anomaly based on the *balance of probability*. The result therefore cannot be seen as being totally conclusive.

Both states in this "Western Belt of Resource Abundance" present with a formidable set of developmental problems that impact on the potential benefit of 'virtual water'.

Firstly, they both have a severely run down economy. The poor state of the Angolan economy is the result of a protracted civil war that has still not reached finality. Although the war has officially ended, the country is still very tense. There is a high level of banditry evident. The high number of unexploded landmines will probably affect the future agricultural potential for some time to come. Normal development is unlikely to take place in the short-term. The state of the Zambian economy is weak, but for different reasons. The problems here are related mainly to underdevelopment and the reliance on copper as a generator of foreign currency. The medium-term prospect for copper is bleak as noted in Chapter 3. Thus the economic problems are likely to deteriorate.

Secondly, both stand to benefit enormously from a 'virtual water' based development strategy. The fact that the rest of the study area is generally arid adds to their potential advantage. Due to the prevailing aridity over the rest of the study area, a 'virtual water' development strategy would mean that 'virtual water' would have to be imported from outside the Southern African region. Both Zambia and Angola could thus use this fact to stimulate trade within the regional context. The benefit of this would be twofold. One the one hand, it could provide the necessary impetus to start an economic revival within Angola and Zambia. On the other hand, it would benefit other states in the study area to trade rather with a neighbour in a softer currency, than be forced to pay hard currency to a distant trade partner.

Potential 'Virtual Water' Importers

One category comprises those states that make them potential 'virtual water' importers due to the combination of specific hydropolitical variables. The category of potential "importers" consists of three sub-sets:

The first sub-set of hydropolitical variables is a combination of:

- high-risk HPRP
- stronger and more diversified economy
- lower agricultural SWE
- higher industrial SWE

Where states present with this combination of variables, they can be regarded as potential "importers" of 'virtual water'. The critical combination of hydropolitical variables in this regard, is the existence of a high level of water need (evidenced in the high-risk HPRP) coupled with the higher level of economic development. One state presented with this combination of hydropolitical variables. This is:

- Zimbabwe

The second sub-set of hydropolitical variables is a combination of:

- high-risk HPRP
- stronger and more diversified economy
- medium agricultural SWE
- medium industrial SWE

Where states present with this combination of variables, they can be regarded as potential "importers" of 'virtual water'. The critical combination of hydropolitical variables in this regard, is the existence of a high level of water need (evidenced in the high-risk HPRP) coupled with the higher level of economic development. One state presented with this combination of hydropolitical variables. This is:

- South Africa

The third sub-set of hydropolitical variables is a combination of:

- medium-risk HPRP
- stronger and more diversified economy
- low agricultural SWE
- high industrial SWE

Where states present with this combination of variables, they can be regarded as potential "importers" of 'virtual water'. The critical combination of hydropolitical variables in this regard, is the existence of a high level of water need (evidenced in the medium-risk HPRP) coupled with the higher level of economic development. Two states presented with this combination of hydropolitical variables. They are:

- Botswana
- Namibia

Of all of the possible combination of variables, the second (economic strength) is undoubtedly the most important. Generally arid conditions prevail within the study area. This, combined with the fact that the potential "exporters" within the study area have significant developmental problems to overcome before they can meet the full 'virtual water' needs of the other basin states, means that the 'virtual water' purchases will have to be made from outside the study area. This in turn implies that sufficient reserves of foreign currency will have to be generated. This can only come from the existence of a viable industrial sector *that is globally competitive.* The emphasis is added, as this is probably the single most important aspect to understand when evaluating the potential of 'virtual water'.

The essence of a 'virtual water' development strategy is that the local economy is integrated into the regional economy, and that the regional economy is integrated into the global economy. There are thus two steps in the process. At best, the first step can be seen to be an advantage within the context of the study area. Trade between states within the study area is generally poor. While this has not been investigated in this research, it is known to be a general condition within Southern Africa. Thus 'virtual water', if embraced as a regional strategy, can become the stimulus to an improvement in regional trade. Significantly, this is recognised in the White Paper on Water Policy for South Africa (DWAF, 1997:2.2.4) which states that:

> "The GEAR aims to boost economic growth by lowering protective barriers in a number of industrial sectors, promoting small and medium sized industry and greater integration with SADC countries as well as internationally competitive manufacturing industry. It emphasises that the South African economy cannot

grow merely through exploitation of crude natural resources, an approach which applies as much to water as to the more traditional area of minerals".

This economic aspect is so important that it needs to be expanded on. The four states in this category coincide with the "Central Belt of Resource Scarcity" previously alluded to. The economic development of these states as a grouping represents a concentration of economic activity within the study area. The grouping is not monolithic however and should not be seen as such.

The most diversified and powerful economy in this grouping is undoubtedly South Africa. It trades substantially with the rest of the world, but due to the years of apartheid based economic policy, it is not fully integrated into the global economy. A manifestation of this is the fact that South African competitiveness in a global context is generally low. South Africa is relatively integrated into the regional economy however. Some may even argue that it dominates the regional economy. That was the rationale to originally start SADCC in the first place. Thus it can be said that at least one of these states has the capacity to trade internationally. The magnitude of this capacity was not quantified by the research and is thus beyond the scope of competence to evaluate further. One strong possibility for South Africa is to expand trade links within the study area, specifically with the two potential 'virtual water' exporters (Zambia and Angola) as this could be mutually beneficial in the longer-term. The White Paper on Water Policy for South Africa is illuminating in this regard (DWAF, 1997:6.6.2). It states that:

> "If it is in the public interest to make sure that the development of water resources, which is often the key factor in enabling economic development to take place, is carefully planned so as to promote rather than restrict such development. Where water is needed to produce water-intensive products such as food, wood and electric power, it may be a more efficient use of resources to import them, rather than attempt to produce them in a water-stressed area. This use of trade between countries and regions as a measure to achieve best use of water has not been properly studied in Southern Africa".

The second most diversified economy in this grouping is that of Zimbabwe. As alluded to in Chapter 3 however, the industrial base is largely driven by import substitution. There is thus a limited degree of international trade. This mitigates against the potential for 'virtual water' trade as foreign currency availability becomes a critical limiting factor. Thus Zimbabwe would need to expand trade within the region as a whole first, in order to benefit from 'virtual water'. A natural trading partner in this regard is

Zambia given the close links that already exist, coupled with the potential that Zambia has shown as a potential 'virtual water' exporter.

The other two states in this grouping, Namibia and Botswana, probably do not have the degree of economic diversity needed to trade in 'virtual water' on a global scale. Given their relative economic strength, they could increase their regional trade. Both are geographically linked to the two potential exporters of 'virtual water', Zambia and Angola.

From this discussion it becomes evident that one of the most important pre-conditions for a 'virtual water' development strategy to succeed, is the existence of a viable industrial sector in an economy. This is needed to fund the purchases of 'virtual water' from the international marketplace. This single factor thus becomes one of the most critical challenges to the states in the study area. The major developmental question to answer, is how to promote economic development that can enable the benefit from the improved gearing that is inherent within an industrially based economy to be enjoyed?

A two-tiered approach is thus seen to be the most appropriate in terms of a 'virtual water' development strategy. The first tier involves trade *within* the regional grouping, specifically designed to enable a more favourable balance of payments condition to prevail *within* the region. This should be supported by a regional trade policy that recognises the fact that certain sectors within certain states are not internationally competitive and are thus in need of support. This is best achieved if a paradigm of regional self-sufficiency is adopted rather than a paradigm of national self-sufficiency. Clearly more research needs to be done in this regard in keeping with the sentiment expressed in the White Paper on Water Policy (DWAF, 1997:6.6.2). The second tier involves trade *between* the regional grouping (SADC) and trade partners geographically located elsewhere in the world. This is the existing pattern of trade for SADC at present.

Another interesting indicator that is manifest within the "Central Belt of Resource Scarcity" is that regarding policy choice. In this regard, an interesting point becomes evident. Botswana has already made a policy choice away from one of "national self-sufficiency" in food as noted in Chapter 3. While this has not yet been reflected in a shift in SWE, this is possibly the result of the generally limited data set that was available. The important point is that a policy shift has been announced, even if the evidence of the impact of that policy shift is not yet evident. South Africa is also approaching that point where a policy shift is taking place, as noted in Chapter 3. This is evidenced in the White Paper on Water Policy (DWAF, 1997) that is strongly demand sided and based on 'virtual water' principles. No indications of a policy shift are evident from either Zimbabwe or Namibia however, and both appear to be trapped in their supply side policy paradigm. Significantly, both South Africa and Botswana are starting to function in terms of their newly found demand side policy paradigm. This is the major difference within the "Central Belt of Resource Scarcity", and tension between these two poles is likely to drive the future hydropolitical dynamics.

Karshenas' Model

From the above analysis, a set of conditions can be generated in terms of the Karshenas Model used by Allan, for the study area. These are presented in Figure 19.

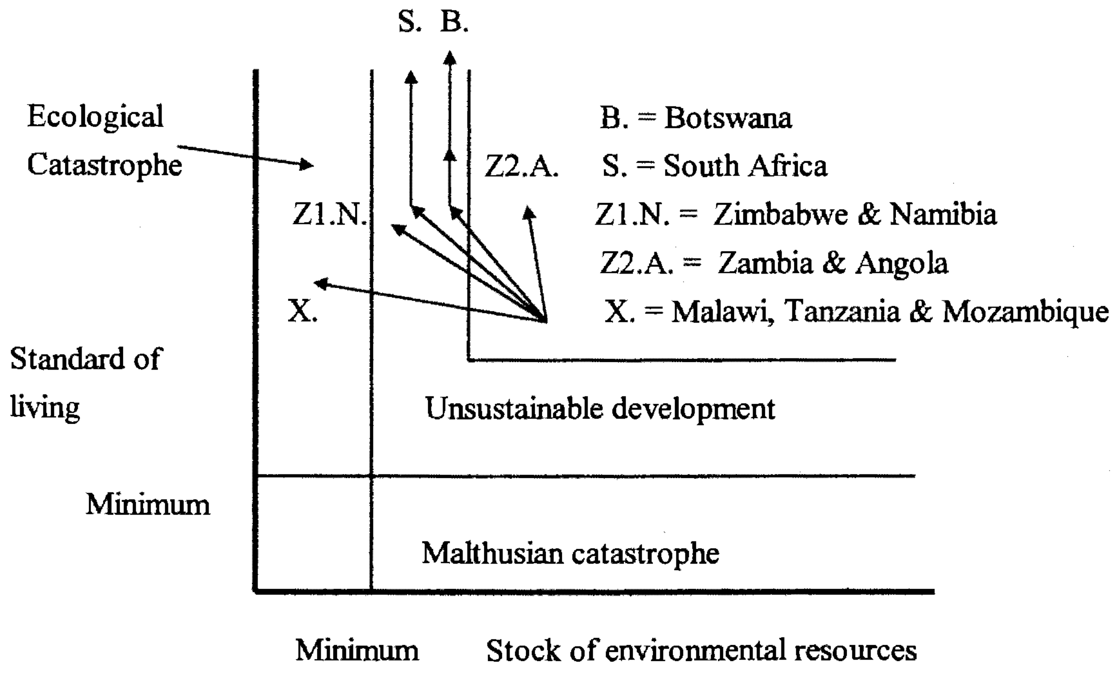


Figure 19. The Situation Regarding Water in the Zambezi Basin and South Africa in Terms of the Karshenas Model used by Allan.

From the above graphic representation it can be seen that four distinct sets of hydropolitical conditions are evident within the Zambezi Basin and South Africa. These are as follows:

- Those conditions where unsustainable development is currently the case and where ecological catastrophe is likely to occur if the current developmental trajectory is not altered. Given the prevailing level of population growth and resulting water scarcity, it is unlikely that the current trajectory can be altered even if the governments' concerned wish to alter it. In other words, policy intervention is unlikely to make an impact on the developmental trajectory of these states. The letter "X." on the graph represents this. These states are those labelled as the "Eastern Belt of Poverty" and are Malawi, Tanzania and Mozambique.

- Those conditions where unsustainable development is currently the prevailing condition, but where a policy choice can result in an adjustment to the developmental trajectory. These political economies are represented by the symbol "Z1.N." on the graph. These states are Zimbabwe and Namibia. If a policy adjustment is not made, then the current trajectory will probably lead to an ecological catastrophe at some time in the future, but a timely policy intervention can still alter the prevailing trajectory. Significantly, both of these states are still functioning in terms of a supply side policy paradigm.

- Those conditions where unsustainable development is, or has been, the prevailing condition, but where a policy choice has already been made, or is about to be made. In the case of Botswana (represented by the symbol "B.") the policy choice has already been made, so the developmental trajectory is likely to move back into the area on the graph that represents sustainable development fairly soon. Empirical evidence of this has not yet manifested itself. In the case of South Africa (represented by the symbol "S."), the policy choice is currently being considered and is embraced in the White Paper on Water Policy. This is likely to result in a change of trajectory once it has been fully implemented. Given the "lag time" between policy-making and the benefits of such a policy, the new developmental trajectory can be expected to lie within the unsustainable portion of the graph for a period of time. The long-term developmental trajectory is likely to move ultimately back into the area of sustainability however. Significantly, both of these states are starting to function in terms of a demand side policy paradigm.

- Those conditions where resource abundance has not yet resulted in a major environmental impact. Under these conditions sustainability is not an issue, so consequently policies relating to resource efficiency are not yet being considered. Under these conditions, policy choices can probably only be effected in a regional context by means of the intervention of an outside hegemonic power, who may offer a series of incentives in order to induce a co-operative policy choice. This trajectory is indicated by the symbol "Z2.A." on the graph which represent the position of the states within the "Western Belt of Resource Abundance" (Angola and Zambia).

Resultant Hydropolitical Dynamics in terms of 'Virtual Water'

Having identified the major actors and variables within the study area, it is now possible to develop a model that shows the probable patterns of hydropolitical interaction that are likely to emerge within the study area. This is achieved by superimposing the actors and variables that have been previously identified, onto the known set of development plans for the study area.

Longitudinal Profile of the Zambezi Basin

The potential development of the Zambezi Basin is illustrated in the following profiles.

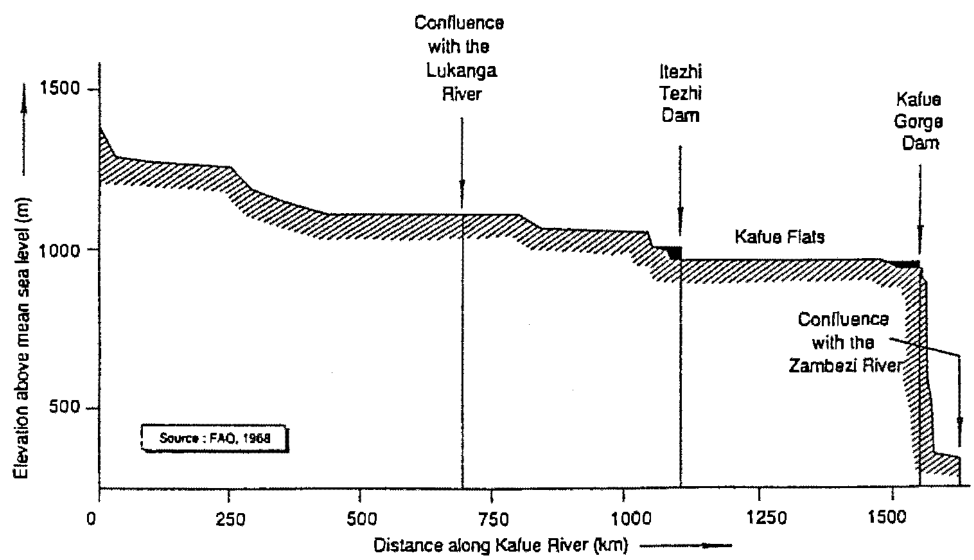


Figure 20. Longitudinal Profile of the Kafue River Indicating Existing Dam Sites (MacDonald *et al.*, 1990d:2-13).

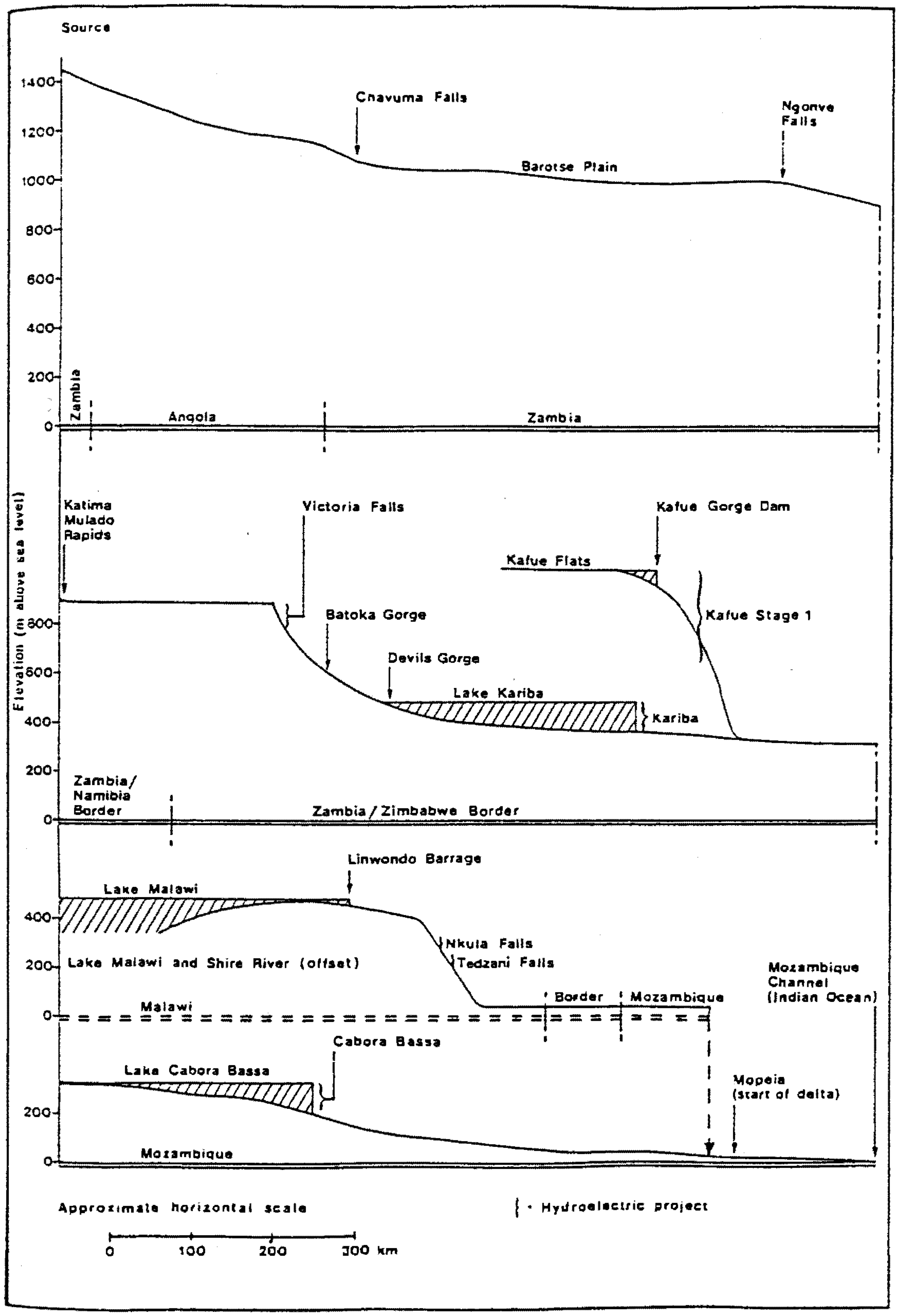


Figure 21. Longitudinal Profile of the Zambezi River Basin Showing Existing Dam Sites (World Bank, 1992:3-3).

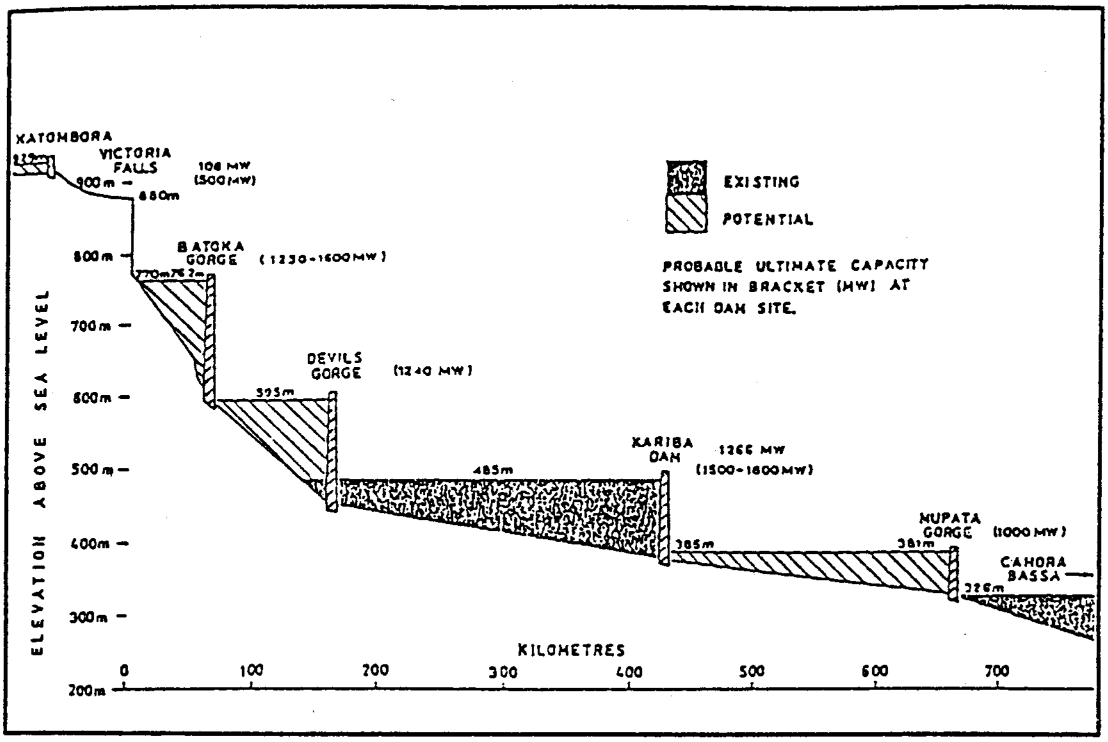


Figure 22. Existing and Potential Development Sites in the Middle Zambezi Basin (World Bank, 1992:3-5; MacDonald *et al.*, 1990d:2-6).

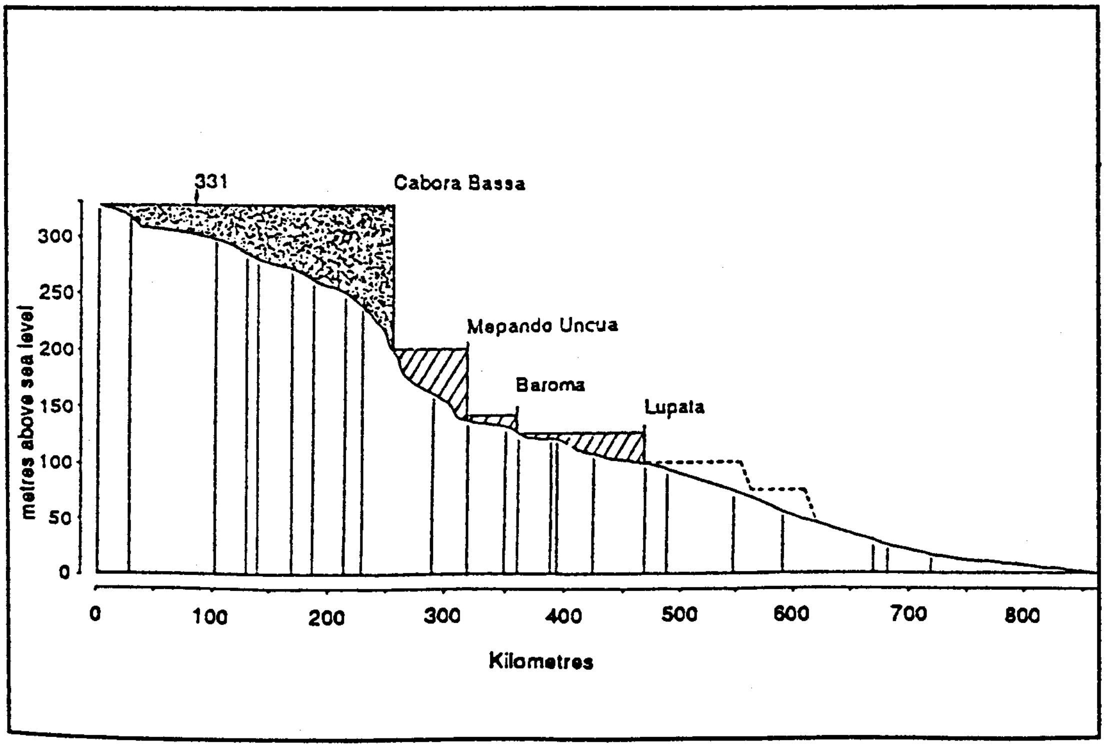


Figure 23. Existing and Potential Development Sites in the Lower Zambezi Basin (World Bank, 1992:3-5).

In order to assess the developmental potential of the Zambezi Basin, the logical point of departure is to determine the best development sites from the natural profile of the river. In Figures 20 and 21, the longitudinal profile of the Kafue River (MacDonald *et al.*, 1990d:2.13) and the Zambezi River (World Bank, 1992:3-3) is given respectively. From these profiles engineers have determined the most suitable sites for the development of dams, taking into consideration the naturally prevailing geology and physical features such as elevation (which is significant for gravity feed and hydroelectric generation). These are presented as Figure 22 (World Bank, 1992:3-5; MacDonald *et al.*, 1990d:2-6), which shows the potential developments in the middle Zambezi Basin, and Figure 23 (World Bank, 1992:3-5), which shows the potential development of the lower Zambezi Basin. No major development has been planned for the upper Zambezi Basin. As can be seen, the ultimate goal of engineers is to convert the Zambezi River into a series of cascading reservoirs in order to harness the full potential of this resource.

It should be noted that hydropolitical factors have not been considered when selecting these potential development sites. In fact it has been noted in discussions with Evans (1997), that had Kariba Dam been proposed in the 1990s, then it would probably not have been built, due to the prevailing negative attitude towards the construction of large dams of this nature. In reality, there has been an upswing in the development of large dams during the current century. Given the long lag-time between the construction of these major projects and the visible evidence of the long-term environmental impact created by them, there has been a general dampening of enthusiasm for such projects as the century has progressed. Of significance to this study, the period of dam construction has coincided with the prevailing supply sided management strategy adopted by many governments, and as the long-term impacts have been felt, there has been a gradual realisation that a more demand sided approach is called for. Considering the high evaporative losses that prevail in the study area (Chapter 2), it can be seen that such a large number of dams would present a huge surface area and hence result in major evaporative losses. It is therefore logical that a balance has to be struck between dam construction and water demand. In short, hydropolitical factors are indeed relevant and should be factored into the overall developmental strategies of states in arid regions.

Development of the Lower Zambezi Basin

Having concluded that there is a so-called "Eastern Belt of Poverty", it is interesting to note that this generally coincides with the lower Zambezi Basin. The implication of this fact is that major developments in that reach of the Zambezi River are probably not going to attract the necessary foreign funding. In other words, the development of the lower Zambezi Basin in the short-term, is not considered to be a likely probability. What is likely to occur instead, is that the capacity of the Cahora Bassa dam will be fully exploited. The tragedy of the Cahora Bassa project is that since construction was completed, no significant power generating capacity that this originally created has been used. This has certainly influenced foreign funders of such projects. Davies (1996b) laments this fact at length. It is a sad indictment of such grandiose projects that Cahora Bassa cost US$ 2,5 billion to construct, but has at best managed to generate electricity at a level equivalent to one of the originally planned nine turbines (Davies *et al.*, 1993:150). This construction cost ignores the cost of protecting the 1 300-km long power line to South Africa that was almost totally destroyed by RENAMO during the protracted civil war in Mozambique. The lower order riparian position of Mozambique, combined with the generally weak *rapport de forces* position of states in the "Eastern Belt of Poverty", is likely to result in no significant development of this stretch of the Zambezi River. Instead, a viable goal would be to reinstate the installed capacity of Cahora Bassa and generate foreign exchange by selling power to states like Zimbabwe and South Africa. This represents a 'virtual water' export to those states that is both viable and sustainable.

Development of the Middle Zambezi Basin

Figure 24 shows the potential and existing development of the Middle Zambezi Basin in the form of a map (MacDonald *et al.*, 1990d:2-5).

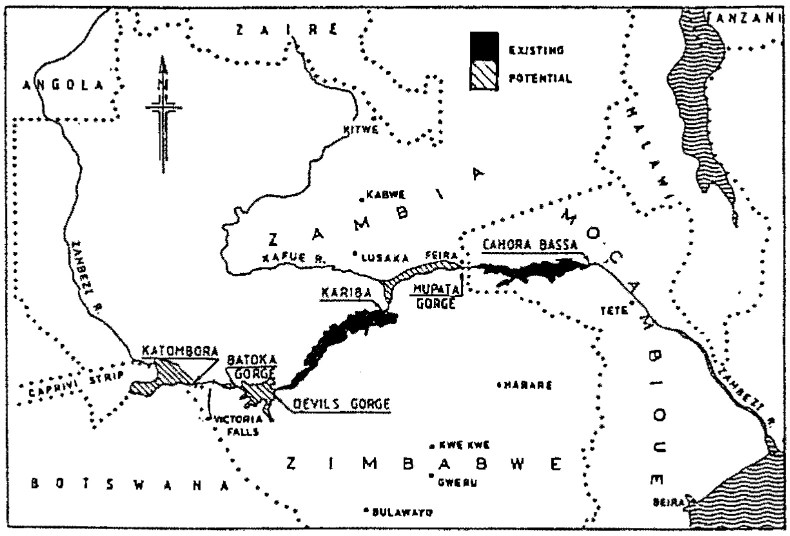


Figure 24. Map of the Middle Zambezi Basin (MacDonald *et al.*, 1990d:2-5).

It is from here that the majority of the hydropolitical dynamics are likely to be generated. The middle Zambezi could be considered to be the hydropolitical "hot spot" of Southern Africa. As a point of departure, the needs of the states in the so-called "Central Belt of Resource Scarcity" must be understood, as these provide the driving force behind the hydropolitical dynamics.

Zimbabwe

The hydropolitical position of Zimbabwe needs to be considered first. As has been noted from the empirical data presented in Chapter 3, Zimbabwe is facing a pressing water scarcity. Coupled to this is the need to have a stable supply of electricity in order to drive the growing industrial sector. Zimbabwe displays a strong supply sided management approach to the problems of water procurement and has a long track record as a major dam building state. The current major project under consideration is the Batoka Gorge Dam, which lies between Victoria Falls and Lake Kariba. This project is regarded as the cornerstone of the Zimbabwe planning (MacDonald *et al.*, 1990e:2.14) and is scheduled to cost a staggering Z$ 1 000 m (Europa, 1996:1070).

The Batoka Gorge Dam is primarily a hydroelectric generating plant with an installed capacity of 1 600 MW. The storage capacity is not significant and the project will be run as a so-called "run-of-river" scheme (Knight Piésold *et al.*, 1993:i). In other words, generating capacity will be directly proportional to the prevailing flow rate of the river. The optimisation of power generation will best be achieved if the scheme is run in conjunction with other hydroelectric schemes already in existence, such as Kariba, Itezhi Tezhi, Kafue and Cahora Bassa (Knight Piésold *et al.*, 1993:vii). The site is highly suited to a "run-of-river" type of scheme, as it lies in a deep gorge with a natural head created by the series of rapids below the Victoria Falls. Optimisation of the electricity generation will be obtained if a regulating weir could be constructed above the Victoria Falls at Katambora (Knight Piésold *et al.*, 1993:11-iii).

Zimbabwe has an electricity generating capacity based on both thermal and hydropower, but additional capacity is needed. Importation from Zambia (Knight Piésold *et al.*, 1993:13-1) and Cahora Bassa (Europa, 1996:1070) it practised. This importation of power appears to be anathema to Zimbabwe's policy of national self-sufficiency however. The implications of this are that while the Kafue 3 Project is a more economical option (Knight Piésold *et al.*, 1993:13-iv), Zimbabwe wants to limit energy imports to 25% of demand. In other words, stated rather bluntly, Zimbabwe is willing to proceed with a project that has a known lower level of economic efficiency simply to maintain a stance of national self-sufficiency. This provides one of the major driving forces to the hydropolitical dynamics in the study area.

Given the magnitude of the project, the required funding can only be secured if the scheme is treated as a bi-national or regional project (Knight Piésold *et al.*, 1993:13-ix). This opens the door to other hydropolitical actors in the study area. As the project consultants note (Knight Piésold *et al.*, 1993:14-iii-iv);

> "Batoka is the best hydropower option which has been investigated on the Zambezi River. Kafue Lower Gorge, wholly within Zambia, has a lower specific generation cost. ... Given the national debt situation, and considering that Zambia has other options for meeting its internal power demands, donor confidence must be *generated* in the Project. ... When deciding on the financing strategy for the Batoka Project, *political issues will have to be addressed*." (emphasis added)

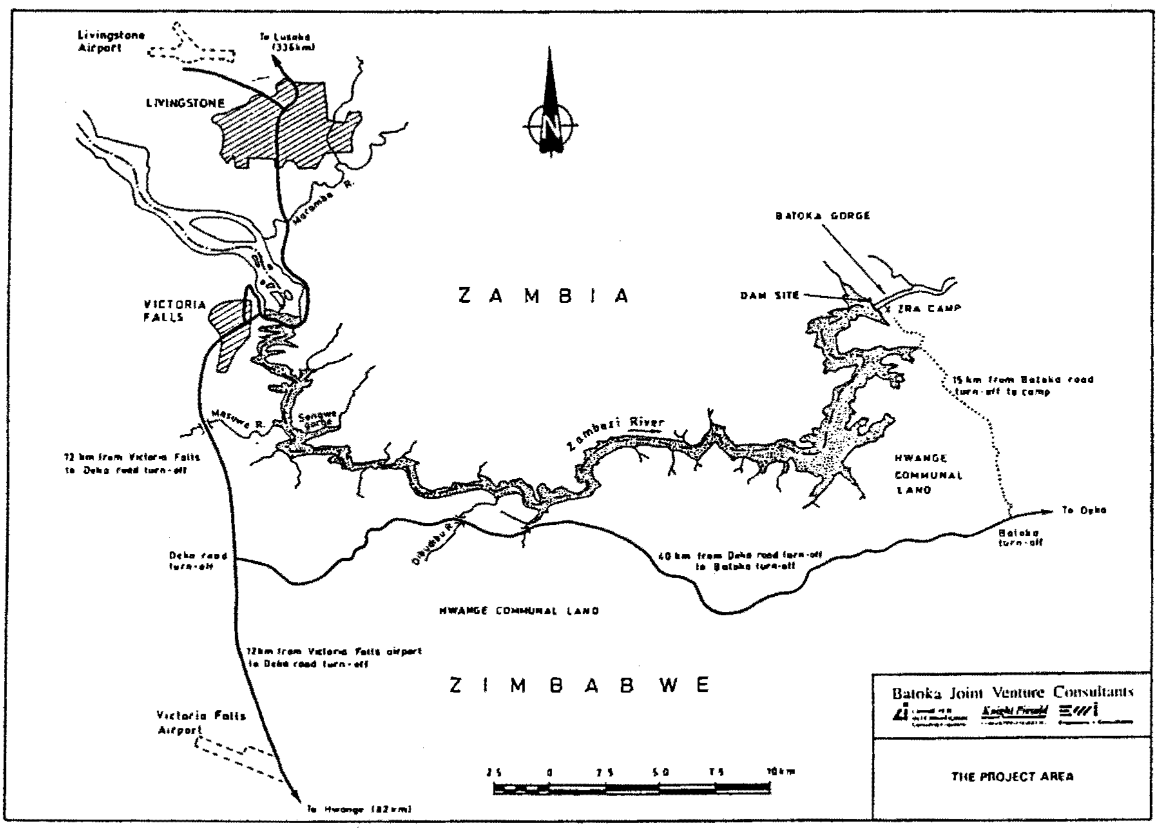


Figure 25. Detailed Map of the Batoka Gorge Project (Knight Piésold *et al.*, 1993:EA1-1).

Figure 25 shows details of the Batoka Gorge Project. This map, in conjunction with Figure 22, show that the dam will force the water to rise to the base of the Victoria Falls, thereby inundating the rapids that are currently used for eco-tourism and the generation of foreign exchange from white water rafting.

There are thus six major points of significance that the Batoka Gorge Project raises.

- The project is not the least-cost option available. Existing capacity is being purchased from the Cahora Bassa Dam but this is seen to be a temporary solution by the government of Zimbabwe. If additional capacity is still needed, the Kafue 3 Project offers a better economic option.

- There will be a major ecological impact as the result of the project. Davies (1996b) notes that the proposed dam will be what is referred to as a "deep release cold reservoir". In other words, the depth of the dam, combined with the fact that it will release water from the bottom of the wall in order to power the turbines, will result in the thermal-separation of water. The deeper water will be of a lower temperature than the prevailing water within the river system, and the mixing that will result after release will alter the ecological balance of the river. This will have a devastating effect on the sub-tropical flora and fauna that naturally exist in the gorge.

- Major international ecological interest groups are likely to be opposed to the project in light of the fact that the Victoria Falls area is a World Heritage Site and known to be ecologically sensitive.

- Zambia is being coerced into the project as a somewhat unwilling partner. Zambia does not need the electricity generated by the project, but will be forced to accept joint financial responsibility. The project will even counter the national interest of Zambia that has chosen to base the existing foreign revenue generation strategy on eco-tourism, which is generated to a large extent from the white water rafting that exists below the Victoria Falls. This rafting is of a world calibre and is a major attraction, which will be lost once the dam inundates the rapids.

- The Batoka Gorge Project actually runs contrary to the national interests of other state actors in the study area and is thus not likely to receive their enthusiastic support.

- The rationale of the project is justified only if viewed from the perspective of Zimbabwean national self-interest.

The town of Bulawayo is faced with a critical water shortage (Arnestrand *et al.*, 1993:35). The local authority argues that the long-term solution is the so called Matabeleland Water Transfer Project (MZWP) (Economist Intelligence Unit, 1996c:10), which would abstract water from the Zambezi River. As previously noted, the economics of this are not favourable, given the elevation of the land and the resultant need to pump the water at great cost if the abstraction point is from within Zimbabwe. Gravity feed would thus be a more economically viable option in the long-term. As also noted previously, one of the reasons why Zimbabwe is pushing ahead with the Batoka Gorge project, is to improve the economic viability of the MZWP by significantly reducing the overall head. Yet again the motivation is based on Zimbabwean self-interest, when alternatives do exist in the form of a largely gravity fed system *if the abstraction point is located in Zambia*, upstream of the Victoria Falls (Alexander, 1996).

Botswana

As already noted, Botswana is at the point where water availability has become a constraint to the development of the economy. This has meant that fairly large and sophisticated water transfer schemes are being planned and implemented. One such scheme was stopped as the direct result of intervention from international ecological pressure groups, which serves as an indicator of their significance as a hydropolitical role-player. This project involved the abstraction of water from the Okavango Delta via a series of dredged water channels in the Okavango Swamps and the Boteti River. Parts of this project have been scrapped and other components have been incorporated into the national water carrier. It is therefore useful to consider the project as it was originally conceived. This project is reproduced in Figure 26 (MacDonald *et al.*, 1990a:2-20), which shows the overall complexity of the design. The quality of the map is unfortunately poor, and details may be further lost in reproduction, so it is considered to be of value to briefly describe the project.

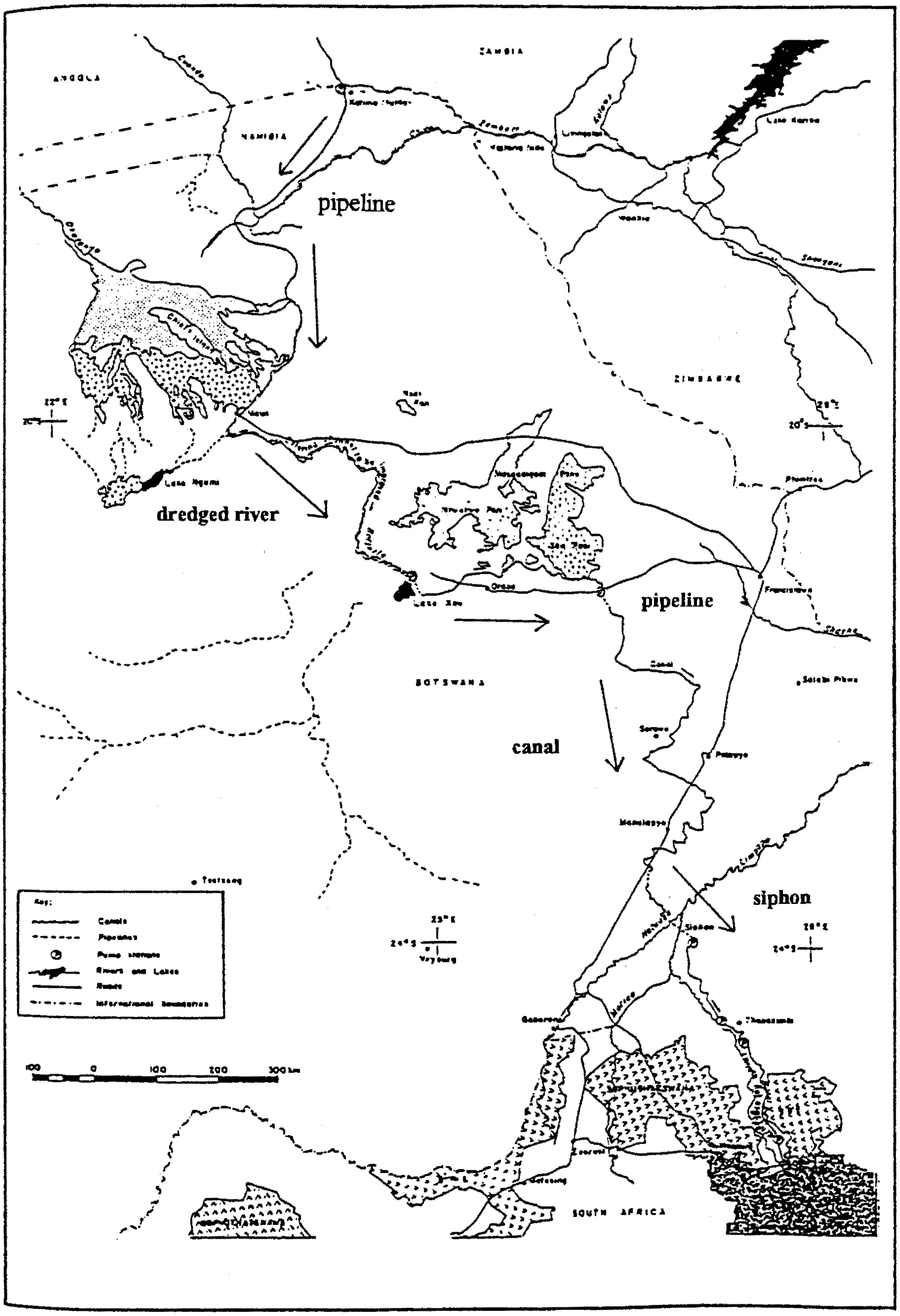


Figure 26. Okavango and Zambezi Water Transfer Project in Botswana (MacDonald *et al.*, 1990a:2-20).

Water was to be abstracted from the Zambezi River near Katima Mulilo. Interestingly, this abstraction point is in Namibia and would have involved a pipeline across the Caprivi Strip and Chobe/Linyati River into Botswana. This would have linked up to Maun and would have supplied a portion of the water to this town. At this point the water would have been channelled via the dredged Boteti River to the mining operation at Orapa, just south of the Makgadikgadi Salt Pans. It would then have been channelled via canal past the towns of Serowe and Mahalapye. A siphon connection would then have taken the water across the Limpopo River to South Africa.

The objections to this project were essentially as follows:

- The ecosystem of the Okavango Delta is extremely fragile and dredging would cause a high level of environmental disturbance.
- Given the high levels of evapotranspiration in the Kalahari Depression, there would have been a major loss of water from the open canal.

Parts of this scheme have been scrapped, but elements remain as components of the North-South Transfer Scheme. The hydropolitical significance of this long-term plan is that abstraction of Zambezi water by Botswana will leave less water available for Zimbabwe. To this extent there is a clash of national interests regarding the use of the resource.

Namibia

As already noted, Namibia is at the point where water availability is becoming a development constraint. The Kasikili-Sedudu Dispute provided an insight into the problems that were experienced by Namibia as the result of a prolonged drought. A solution to the water scarcity problem therefore lies in the abstraction of water from the Zambezi as a matter of some priority. As in the case of Botswana, any abstraction of this water will disadvantage Zimbabwe. Again this case presents a direct clash of national interests. In the case of Namibia and Botswana, a degree of co-operation is required, as Botswana needs to run a pipeline across the Caprivi Strip, which would need the support and approval of Namibia. Namibia and Botswana could thus be regarded as allies in this case. Thus alliance formation can be expected with a Namibia/Botswana bloc emerging as a combined higher order riparian likely to oppose the only significant lower order riparian, Zimbabwe.

South Africa

It has already been shown that South Africa has a pressing need to gain long-term strategic access to water. This issue is likely to become one of national survival fairly soon. This implies that the issue will become one of "high politics". One option for South Africa is to negotiate access to the Zambezi River.

The White Paper on Water Policy opens the way for this. Provision is made for trading in water-use allocations (DWAF, 1997:6.5.3). This is a novel concept, and recognises the economic value of the commodity. While this is meant for use within South Africa, it is in keeping with the spirit of trading water for other benefits across the borders of the state. The LHWP can be seen as an example of this. IBTs are recognised as being a vital means of guaranteeing the spatial distribution of water from one basin to another (DWAF, 1997:6.6.1). "Because water does not recognise political boundaries, whether national or international, its management will be carried out in catchment areas although the policy of subsidiarity does not interfere with the need for a national and international perspective on water use" (DWAF, 1997:6.9.1). The Department of Water Affairs is to be empowered to actively support the development of international law to guide the management of shared international river systems on an equitable basis (DWAF, 1997:6.9.2). Principle 11 states that international water resources will be used in a manner that benefits all parties and the allocations for lower order riparians will be respected (DWAF, 1997).

The best option for this access is via Botswana, given the favourable engineering and geological factors that this state offers. The implications of this are as follows:

- South Africa will have to negotiate access, as it is not a Zambezi Basin riparian state.
- This access will make South Africa a lower order riparian vis-à-vis Botswana but a higher order riparian vis-à-vis Zimbabwe.
- Any water abstracted by South Africa would mean less water for Zimbabwe with the result that a clash of national interests is inevitable if seen in zero-sum terms.

Significantly, the White Paper on Water Policy (DWAF, 1997), can be seen as a deliberate attempt by a major actor, to move away from the zero-sum principle that is inherently conflictual (because all actors are seen as opponents), to a win-win approach (where all actors as seen as participants). This represents a major change in the future pattern of hydropolitical interaction in the study area. In this regard South Africa can be said to be leading the regional grouping in keeping with Lowi's theory of hegemonic co-operation. A summary of the principles on which the White Paper on Water Policy (DWAF, 1997) is based has been included as Appendix "G" for the convenience of the reader.

Two further states are geographically located along the middle Zambezi. These are the states in the so-called "Western Belt of Resource Abundance". Their unique set of hydropolitical variables means that they are likely to focus on the supply side of the overall hydropolitical equation. Their positions need to be considered, as they can maximise their hydropolitical advantage vis-à-vis the so-called "Central Belt of Resource Scarcity", who are likely to focus on the demand side of the overall hydropolitical equation.

Zambia

As has been shown, Zambia is one of the major sources of available water within the study area, as it has a resource surplus beyond its medium-term needs. Zambia is being forced into the Batoka Gorge project as an unwilling partner. It has been shown that a more viable option is the expansion of hydroelectric capacity at Kafue 3 (Knight Piésold *et al.*, 1993:8-I; 13-iv). This would benefit Zambia directly, as it would be in a position to efficiently convert water resources into electricity and thus become a supplier of 'virtual water' to Zimbabwe. This would result in a more equitable distribution of development in spatial terms between the two states, while providing the least-cost, most environmentally friendly option available. Given the under-utilised agricultural capacity, Zambia is also in a position to provide agricultural products to the study area in the medium-term. South Africa could supply agricultural knowledge as an added incentive for co-operation, given the weakness of the commercial agricultural sector. Zambia is thus the only state in the study area to have the potential of becoming an exporter of both 'virtual water' and actual water. Zambia can thus be regarded as a significant potential hydropolitical actor in Southern Africa. In this capacity, it could leverage significant advantage by co-operating with one of the other major hydropolitical actors (South Africa and Zimbabwe). The best option available to Zambia is in fact to co-operate with a hegemon, as it is too weak to oppose the hegemon directly. Zambia could use this favourable hydropolitical status to improve the otherwise weak *rapport de forces* position that it generally has. If one extends this argument to include the implications of the mooted Lualaba-Zambezi IBT, then Zambia's hydropolitical status becomes enhanced even further, because the entire increased volume that this IBT would introduce into the Zambezi Basin would flow primarily over Zambian soil. Zambia would then effectively become the upstream riparian vis-à-vis all of the other lower order users.

Angola

As has been shown, Angola is in the most favourable position within the study area, regarding total resource availability. The long-term development of this involves either agricultural or electricity generation capacity, both of which are major sources of 'virtual water' exports. Angola will need some time to develop this potential, given the devastating effect caused by the civil war on the infrastructure and economy. With the increased hydropolitical importance of Zambia, regarding the proposed Lualaba-Zambezi IBT, Angola will be in a relatively weaker position to project itself as a major regional hydropolitical power, but will always be of importance. The best option open to Angola is to reconstruct its economy on the rationale that it can provide 'virtual water' in the form of either agricultural produce or hydroelectricity.

Probable Hydropolitical Interaction

Given the above, the probable pattern of hydropolitical interaction is likely to be driven by the demand for water from the states in the "Central Belt of Resource Scarcity". In terms of Lowi's theory of hegemonic co-operation, the main actor in this regard is thus likely to be either South Africa, or Zimbabwe, depending on the unit of analysis chosen. This becomes the best starting point for an analysis of probable hydropolitical interaction, remembering that Zimbabwe is ostensibly locked into the supply sided policy paradigm, whereas South Africa has moved into the demand sided policy paradigm.

Given the existence of the SADC Protocol on Shared Watercourse Systems, South Africa is likely to play the hegemonic role of regime creation and rule enforcement. The White Paper on Water Policy has committed South Africa to this role as a clear policy statement (DWAF, 1997:6.9.2). Within the SADC ELMS forum regional water development will thus be discussed. As already indicated, the first project likely to be debated is that of Batoka Gorge as it has been shown that the success of this rests on the fact that it has to become a regional issue in order to raise the needed finances. Fulfilling the role of hegemon, South Africa is thus likely to oppose this project. In this effort, South Africa is likely to gain the support of Zambia, given the *rapport de forces* position between the two states, in conjunction with the fact that Zambia does not actually need the project. The support from Botswana and Namibia can probably be obtained through lobbying.

The outcome of this series of interactions is that Zimbabwe is likely to feel threatened. Zimbabwe's likely course of action is to act as hegemon within the Zambezi Basin itself, by using the SADC Water Protocol to further their own national interest. Evidence of this exists (Tumbare, 1997) with the attempt to use the Protocol to justify why the Zambezi River Authority (ZRA), of which they are already the dominant partner, should be expanded to encompass the entire Zambezi Basin. The argument that is likely to be used to exclude South Africa is that it is not a legal riparian. Given the strong posture of national self-sufficiency that Zimbabwe displays, this objection is likely to be vociferous. As Davies (1997) notes,

> "South Africa will have to fight Zimbabwe before an IBT is developed. Zimbabwe has its own water supply problems and would be committing resource suicide to allow an IBT" of this nature to proceed.

A second series of negotiations are thus likely to be launched. South Africa can strengthen her position if the Minister of Water Affairs and Forestry, Kader Asmal, starts adopting a high profile in water-related international fora. Examples of these are the Commission on Large Dams, and via diplomatic initiatives aimed at securing co-operation in areas of policy development and management support systems with other basins in Africa such as the Nile, Zaire (Congo), Chad and Niger. Through bilateral diplomatic efforts, South Africa can try and convince Zimbabwe that the regional interests would best be served if Zimbabwe purchases the needed electricity from Cahora Bassa and Kafue 3, thereby negating the need for the Batoka Gorge Dam. As part of this diplomatic effort, attempts are likely to be made to get Zimbabwe to shift from the current paradigm of national self-sufficiency, which is evidenced by a strong supply sided management posture and is inherently conflictual, to a more demand sided position. In order to do this a form of inducement could be offered.

Under the current hydropolitical conditions prevailing at the time of writing, the best form of inducement is the negotiation of access to waters from the Zaire (Congo) Basin, as this could benefit all of the states in the "Central Belt of Resource Scarcity" including Zimbabwe. This brings the Democratic Republic of Congo into the overall hydropolitical equation. No analysis was made of this state during the current research, so little can be said authoritatively at this time. The Democratic Republic of Congo, as a new member of SADC, can improve its overall position, by translating the favourable hydropolitical status that it is likely to have, into political advantage, by trading water rights in return for other developmental concessions. In this sense, the Democratic Republic of the Congo can play off one actor against another, maximising its own advantage in return for granting access to the largest volume of water available in the entire region. To this end the Zaire (Congo) River is some five times larger in volume than the Zambezi River (Table 1). Significantly too, the Zaire (Congo) River is not as stochastic as the Zambezi River is, so by introducing water from the larger basin, it would result in a less erratic and more predictable stream flow in the Zambezi Basin. This would negatively impact on the ecology however and would attract the interests of international ecological pressure groups.

Assuming that the Lualaba-Zambezi IBT is successfully negotiated, five significant conditions will then prevail in Southern Africa.

- There would be a significant shift away from the zero-sum basis of the hydropolitical interaction that is driven by the prevailing supply sided policy paradigm, to a more equitable win-win approach that is inherent to the demand sided policy paradigm. This implies a significant reduction in conflict potential.

- The states of the "Central Belt of Resource Scarcity" would all stand to gain as the result. The inherent alliance formation within this grouping between Namibia/Botswana in order to oppose Zimbabwe would thus be prevented.

- The biggest winner would be the state that has been instrumental in bringing the Democratic Republic of Congo into the overall hydropolitical configuration. If this were South Africa, it would then be in the most favourable *rapport de forces* position within the overall basin. This would enable South Africa to provide a very strong inducement to the other Zambezi Basin riparians who may otherwise oppose South African attempts at gaining access. If on the other hand it were Zimbabwe, then it could use this favourable *rapport de forces* position to exclude South Africa, unless it could gain an advantage from including the latter.

- There would probably be a resultant build-up of pressure from international ecological interest groups, as an IBT of this nature is likely to a have a major long-term impact on the entire basin. One of these impacts will be the effects of flow regulation on the upper Zambezi, which to date has not had any major dam development. Another impact is likely to be the importation of aquatic flora and fauna, which occur in the Zaire (Congo) Basin, and which may not occur in the Zambezi Basin. There are likely to be other issues as well.

- Of interest in this scenario, the Lualaba-Zambezi waters would flow past Botswana, and not through it, so this state would have an added interest in co-operating with South Africa. This approach would mean the development of an IBT across Botswana to South Africa. Botswana would thus benefit from the increased resource availability to themselves, as well as the revenue that the operation of such a project would generate. By selling the services to South Africa, a significant amount of both the capital costs and running costs could be redeemed.

Another alternative set of scenarios is based on the short-term needs of the states within the "Central Belt of Resource Scarcity". These are likely to include the abstraction of water by Botswana, Namibia and Zimbabwe. An analysis of these options reveals the following:

- Zimbabwe has a critical water need in the Bulawayo area. Pumping costs impose a high economic value on this water, so any efforts to reduce this cost would be beneficial in the long-term. Given the high cost of this water, it would not be economically feasible to use it for agriculture, which has a low SWE. Given the stance of national self-sufficiency evident, Zimbabwe would probably want to have total control of this scheme, and would most likely consider the attainment of this goal as being worth the higher cost. This is one of the reasons why the Batoka Gorge Project makes such sense to Zimbabwe.

- Botswana has a need to abstract water as part of the overall national development strategy and has direct access to the Chobe/Linyati River. This would imply pumping costs, whereas the abstraction of water directly from the Zambezi at Katima Mulilo would benefit from the advantage of partial gravity feed. The latter would thus probably be the best option for Botswana, but would involve negotiating access across the Caprivi Strip.

- If South Africa could limit the planned abstraction of water from the Limpopo Basin by Botswana, in favour of the Zambezi River by means of negotiations, then South Africa would be in a better position regarding the Limpopo River, given the fact that South Africa is a lower order riparian in that river system. It should be remembered that the Limpopo is the second largest basin available to South Africa, and that the resource abstraction is already considered by some to be excessive.

- Namibia has probably the greatest need of all to gain immediate access to new surface water resources. This is probably best obtained from an abstraction point close to Rundu on the Kavango River. An abstraction point closer to Katima Mulilo would have the advantage of a gravity feed, but would involve initially higher construction costs, as the pipeline through the Caprivi Strip would be longer. This may become the only long-term option if international ecological interest groups oppose abstraction plans from the Kavango River.

Given these sets of conditions, all three states could benefit from the construction of a weir at Katambora for the following reasons:

- Such a weir would be part of the long-term development of the Batoka Gorge Project and could thus be viewed by Zimbabwe as a step in that long-term direction.

- The siting of this weir, while bound to cause some ecological disturbance, is likely to cause less disturbance than the siting of a weir at Mambova Rapids (Alexander, 1996).

- This site would provide the least-cost option for Zimbabwe but the highest-cost option for Botswana and Namibia (Alexander, 1996).

- This site would provide a potential delivery point to South Africa (Alexander, 1996).

The political aspects of this siting would be complex however, but given the likelihood of the SADC Protocol on Shared Watercourse Systems being supported by South Africa in terms of Lowi's theory of hegemonic co-operation, this could probably be overcome. Zambia would benefit directly as this would result in a nett inflow of funds in return for the water, as has been the case for Lesotho due to the LHWP. The siting of an abstraction weir upstream of Katima Mulilo would result in the following sets of conditions:

- The site would be wholly within Zambia and would thus be less complex politically.

- The valley at this point is relatively steep and narrow with no features of particular ecological or scenic importance (Alexander, 1996).

- The naturally high elevation would mean that gravity feed could largely be used to supply distant points such as Grootfontein in Namibia, Francistown in Botswana and Bulawayo in Zimbabwe (Alexander, 1996) with minimal pumping requirements. This would significantly reduce long-term operating costs.

- The additional distance for the pipeline would imply a higher initial cost of construction, but this may be offset in the longer-term by the lower pumping costs.

Finally, the long-term implications for South Africa need to be examined. As has already been noted, the best access point for South Africa to the Zambezi Basin is via Botswana. Again, as previously noted, Botswana is potentially falling increasingly under the American sphere of influence. The degree of this influence is unclear however, so this may not be a major factor. South Africa could thus make itself more vulnerable to the USA by developing a dependency on the water from the Zambezi Aqueduct. The apparent solution to this problem lies within the concept of 'virtual water'. Inherent within a 'virtual water' based development strategy is the concept of 'returns to water'. In other words, the need for the water provided by the Zambezi Aqueduct would be minimised by adopting a demand sided management strategy within South Africa. This is being done in terms of the White Paper on Water Policy (DWAF, 1997). Stated differently, should South Africa fully implement a 'virtual water' based development strategy and ruthlessly impose a strong demand sided management solution, then South Africa would only have a minimal reliance on the water from the Zambezi Aqueduct. This in turn would imply that South Africa would then minimise the potential for external influencing that the USA could exert via Botswana.

Problems Created by the "Eastern Belt of Poverty"

The above analysis of probable hydropolitical interaction has thus far been centred on the actors with the stronger *rapport de forces* positions. What of the weaker states in the Zambezi Basin that face the combined problem of high population pressures on natural resources such as water and land, and low economic activity? The so-called "Eastern Belt of Poverty" needs to be addressed, as they are hydropolitical actors too. The best possible options within the 'virtual water' development strategy are therefore likely to be as follows:

- Given the fact that these states have a high probability of becoming the source of significant quantities of migrants, which would most likely be attracted to the more developed states within the "Central Belt of Resource Scarcity", the latter have a natural interest in preventing this from occurring.

- Existing attempts by these states to police their borders have proven to be ineffective, with migrants still managing to infiltrate these states in significant numbers. Even South Africa, under the form of authoritarian rule that prevailed during the latter years of apartheid, failed to seal the borders totally. Joint policy measures in this regard, applied in a regional context, seem to be the most likely to succeed. In fact it could even be predicted with some degree of certainty that states like South Africa and Botswana would be reluctant to sign SADC Protocols that would enable the free movement of people within the region, for fear of being inundated by refugees. This in turn would act as a definite deterrent to regional integration efforts within SADC.

- One of the most effective ways of ensuring that potential migrants stay in their country of birth, is to encourage economic development within those states. In this regard projects such as the previously mentioned Maputo Development Corridor and the ALUSAF Smelter Project are to be encouraged. Such projects employ large numbers of people and consume electricity, which has been shown to have a high 'virtual water' content. They can also generate additional economic development resulting in the benefits of a multiplier effect being experienced in the local economies.

- Another strategy to be considered is to reduce the number of people competing for a resource. Attempts at population control, even under conditions that are highly authoritarian and thus presumably easier to enforce (such as those attempted by China), have shown that this is an extremely complex problem. The solution therefore lies in attempts to raise the issue of population control as a regional problem and therefore to encourage international regional organisations such as SADC to deal with these in the form of joint policy. 'Enmeshment' and 'spillover' is thus necessary from the water issue-area to the population issue-area (first and second subproblems).

- Given the fact that these states generally have an agriculturally based economy, efforts at the improvement of production should be encouraged as part of a regional strategy. The transfer of technology should thus be encouraged, with South Africa having the potential to play a major role in this regard.

Environmentalists as Hydropolitical Actors

It has been noted that dams and IBTs all result in a generally negative environmental impact. It has also been noted that the environmentalists represent a significant source of potential foreign pressure. It was largely through their intervention that the Okavango Delta dredging was stopped. They are also likely to be the major international pressure group that will prevent Namibia from abstracting too much water from the Kavango River. The same will probably hold true regarding the planned Batoka Gorge Project. Environmentalists are thus considered to be a major hydropolitical actor for the following reasons:

- Large IBTs such as those being contemplated need to be financed from foreign sources. International bankers are less likely to consider such funding in the face of a negative high-profile campaign that is launched and managed by such pressure groups.

- Aquatic ecosystems in arid regions are known to be fragile. They are known to be unique directly as the result of the fact that they are stochastic in nature. IBTs and large impoundments interfere with this stochasticity by introducing an element of regulation into the overall flow pattern. Such schemes therefore have a definite impact on the ecosystem as a result.

- IBTs are known to introduce organisms into a basin that do not naturally occur there. The economic impact of this fact can be astronomical as has been evidenced by the case of the Nile Perch. The introduction of this fish species into the lakes of the African Rift Valley has caused the collapse of fisheries in certain cases. This in turn has had a major detrimental impact on the livelihood of local people that have relied on fishing as a source of protein.

- In the case of the proposed Lualaba-Zambezi IBT, there are a unique set of ecological issues that will be raised. The Zaire (Congo) Basin is tropical and has a certain biodiversity as a result. It is also less stochastic which has resulted in a given assemblage structure within this ecosystem. The Zambezi Basin is different. Stochasticity has resulted in a different and sometimes unique biodiversity. Research that has been done elsewhere (Davies *et al.*, 1993:175) has shown that biodiversity tends to be reduced after an IBT begins operating. This fact becomes more complicated when one considers that the proposed Lualaba-Zambezi IBT will ultimately discharge into another basin within South Africa. There will thus be an ultimate linkage between three distinct river basins, each with their own ecological dynamics and biodiversities. The environmental issues are thus likely to be extremely complex in nature.

- The concept of 'virtual water' has sustainability as an inherent factor within the approach. A development can only be sustainable if it results in a minimal ecological disturbance as the result of a given policy option. 'Virtual water', is thus by its very nature a development tool that is relatively environmentally friendly, and as such is likely to be better embraced by environmentalists than other approaches. 'Virtual water' as a policy base, also implies that the physical volume of water being transferred is kept to a minimum. It therefore acts as a kind of brake on the demand for actual water being delivered through IBTs.

- Man is in the final analysis a part of his own environment and will thus be influenced by policies that impact on that environment. This is evident in the Karshenas Model, which forms one of the theoretical foundations of the current study. Ecologists are thus best seen as friends rather than foes.

Environmentalists are thus clearly hydropolitical actors of considerable importance. It is thus illuminating to note that the hegemon in the study area (South Africa), has embraced environmental sustainability as a fundamental pillar on which the water policy has been developed (DWAF, 1997: 6.3.2; 4.2.2; 5.2.2). One of the direct effects of this has been the active involvement of South African aquatic scientists in determining the instream flow requirements, which form the basis of the so-called "reserve".

Regional 'Virtual Water' Balance

The above analysis raises a burning question. If a 'virtual water' development strategy is seen to be the logical solution to the problem of water scarcity in the study area, then to what extent is the water budget within the study area likely to be balanced by such a strategy? The detailed answer to this is unfortunately beyond the scope of this research, but it could be considered as a worthy research problem at some later stage. This is consistent with the White Paper on Water Policy (DWAF, 1997:6.6.2). At best a cursory answer can be considered to this question. This will be attempted by using the state groupings that have emerged from this research.

"Western Belt of Resource Abundance"

It is true that the states within the so-called "Western Belt of Resource Abundance" have a considerable asset base that is not utilised. These two states, Angola and Zambia, are beset by a number of internal problems, the nature of which is beyond the scope of this study. Suffice it to say that they are unlikely to be in a position to provide the 'virtual water' deficit being experienced by the other political economies in the study area in the short-term. They could begin to adopt the 'virtual water' development strategy however, which implies the following:

- That the other states in the study area, which are economically stronger, would benefit by supporting this strategy through a series of bilateral or multilateral agreements, that guarantee an importation for the products that contain 'virtual water', and that are produced by these developing economies.

- That a conscious decision should be taken within a regional forum such as SADC, to support the infrastructural development projects that are needed by the developing states in order to harness the water that they naturally have, and convert it into products or services. This means that credit guarantees should be underwritten for projects such as the rehabilitation of hydraulic installations in Angola that have been damaged due to armed conflict.

- That the economically stronger states such as South Africa and Zimbabwe should make an effort to transfer technology to these developing economies, especially regarding agronomy and other related agricultural sciences.

In this way these developing states will be in a position to benefit by means of a more spatially balanced regional developmental pattern. This in turn can play a role in providing viable employment opportunities for persons that would otherwise have no option but to become economic migrants.

"Central Belt of Resource Scarcity"

There is a great demand for water within this portion of the study area. Unfortunately the research design for this study did not attempt to quantify the actual magnitude of the water needed. As a best guess situation, it is presumed that the magnitude required is significantly larger than that which is available from the "Western Belt of Resource Abundance". This implies the following:

- A portion of the water deficit can be met by the importation of 'virtual water' from *within* the study area by means of trade. It could thus become a regional policy within a forum such as SADC to give preference to trade with member states if this trade helps to balance the regional water budget. This is part of the first tier of the two-tier strategy that was discussed on page 219. This is part of the solution to the third and fourth subproblems.

- The remainder of the water deficit will have to be made up via trade originating from *outside* of the region. This is part of the second tier of the two-tier strategy that was discussed on page 219. The global market for cereals thus becomes of increasing significance. It is presumed that grains such as wheat are probably not going to be grown in significant quantities within Southern Africa to meet the regional needs. This is not a problem however, as there is a production surplus that originates from states such as Canada and parts of Central Europe, at subsidised prices. The limiting factor in this regard is the generation of foreign currency in order to pay for these imports. This is part of the solution to the third subproblem.

- This implies that trade should be selective with a definite policy decision being made to favour a given source of 'virtual water'.

- The international trade in cereals should thus be monitored closely, specifically to determine what the impact of the liberalisation of global trading regimes is likely to have on the price and availability of such products in future.

In light of the fact that this study was not designed to quantify the magnitude of the intra-regional trade in 'virtual water', this could be regarded as a new research priority, in keeping with the White Paper on Water Policy (DWAF, 1997:6.6.2). It is presumed at this stage that the water deficit would probably not be fully met via trade with states such as Zambia and Angola in the short-term, which would necessitate trade with partners outside of the region.

"Eastern Belt of Poverty"

The states in this belt pose a significant problem indeed. States such as Mozambique have such weak economies that even if massive foreign aid was provided, a level of self-sufficiency is not likely to be reached in the medium-term. Although there is a certain availability of water in these states, they are likely on balance to become nett importers. Given their lack of economic diversification, these political economies are unlikely to become a contributing part of the overall water equation in Southern Africa. Their role as hydropolitical actor is thus likely to remain a demand driven one.

SADC Water Sector

The SADC Water Sector that was created as the result of the Protocol on Shared Watercourse Systems in the Southern African Development Community Region met for the first time in February 1997. Phera Ramoeli of the SADC Water Sector said,

> "The idea is that at the end of it all water will be a cause for co-operation rather than conflict as water becomes scarcer. What we have is a protocol which outlines how best water can be utilised, even if it means transferring

water from regions of abundance to regions of need" (Business Report, 27 February, 1997).

Regional co-operation in water management under the auspices of SADC is therefore set to become a reality and South Africa is intending to play a leading role as indicated by the White Paper on Water Policy (DWAF, 1997). This makes the understanding of the fundamental hydropolitical dynamics of Southern Africa all the more relevant. In this way expectations regarding 'spillover' and 'enmeshment' can be placed in their proper perspective.

Conclusion

From the foregoing analysis it can be seen that a given set of hydropolitical variables have been isolated. A number of hydropolitical actors have also been identified. The overall hydropolitical dynamics within the study area have been modelled by taking both the variables and actors, and by superimposing these onto the known set of empirically derived hydrological and population statistics. It has therefore been concluded that 'virtual water' is a solution for certain states only, as a pre-requisite for benefit to be derived is the existence of a degree of economic diversification which not all states have. It has therefore been concluded that while the trade in 'virtual water' is largely the solution for the more developed economies in the study area, the volume of trade needed is most likely to be of an order of magnitude greater than that which can be provided by the states that are water abundant. This may not be a major problem however, as the 'virtual water' based development paradigm has an inherently strong element of demand sided management. It could thus be concluded that with the ruthless imposition of such a management approach, the water shortages would probably become less apparent as the shortages are partly induced by policies that allocate water to economic productive processes that have a low return to water. The White Paper on Water Policy recognises this reality.

Stated differently, it could be concluded that water scarcity in arid regions is largely the result of inefficient agricultural practices, which in turn are the manifestation of a national policy of self-sufficiency. At the risk of going too far, it could be said that without the desire to irrigate crops that yield low cash values, there is less of a water shortage in the first place!

A concluding remark also needs to be made about the problems that were experienced with the SWE data. Clearly, the data sets that were available were too limited to make an in-depth analysis. This is lamentable as the author considers these concepts to be of great value. Their major value is that that they manage to isolate a key set of hydropolitical variables. These concepts can be streamlined in future, and should not be discarded just because the overall data yield was problematic in certain cases. The criticism on the weakness of the database is valid, but judgement should not be prematurely made of the overall viability of the concepts themselves. Rather than throw the baby out with the bath water, renewed efforts should be made to improve the quality of data needed for such research. The Water Research Commission can play a crucial role in this regard.

CHAPTER 6

CONCLUSION

This study has been an attempt to seek a solution to the problem of increasing water scarcity within the Zambezi Basin and South Africa. The basic premise has been to analyse the probable political ramifications that are likely to result from the projected resource scarcity. The research has been in essence a study of dynamics rather than structures, with a goal being to establish a basis for policy intervention.

The First Hypothesis

The first hypothesis is that water scarcity within the study area is likely to cause joint functional co-operation in the development of the shared water resources that exist between all Zambezi Basin riparian states and South Africa.

It has been shown that there is an increasing water scarcity over the entire study area. This scarcity is directly linked to population growth. Where the available water resources are generally limited, the impact of population growth is more dramatic. Mozambique provided a classic example of this, as did Tanzania and Malawi. Where the available water resources are limited, but the population level is low, then the scarcity is less evident. The best example of this is Botswana. In this case the WSI projections are moderate considering the prevailing arid nature of the climate in Botswana. Namibia shows a similar trend. Where resource availability is generally abundant, the impact caused by the growing population is greatly reduced. States such as Angola and Zambia are examples of this. Thus it can be concluded that there is an increasing water scarcity in the study area which is largely population-induced, but the impact varies largely as a result of the availability of water in the first place. The problem of water scarcity is common to all states, only the impact varies slightly.

Having shown that there is in fact an increasing water scarcity, attention can be shifted to co-operation as a possible solution. To this end it has been shown that a recent initiative has been the SADC Protocol on Shared Watercourse Systems. This Protocol was the result of a ZACPLAN project known as ZACPRO 2. This Protocol was the first instrument that was adopted by SADC just prior to South Africa becoming a member. Significantly, this instrument has been used in terms of the future policy planning for at least three states of consequence. These are Botswana, Zimbabwe and South Africa. It has been shown that these three states are also facing critical water shortages in the near future. There is thus a coincidence between the onset of the water scarcity and the apparent desire to co-operate within the framework of a regional policy. There are three important points to note in this regard:

Firstly, the SADC Water Protocol gives a solid framework for co-operation, but it devolves the responsibility for creating structures for the management of shared watercourses down to the level of each riparian state. In other words, SADC provides a guideline only with limited institutional support. The ELMS has been established in Lesotho, but the institutional capacity in general is weak at present. The Protocol specifically notes in Article 6 that the regulatory and financial framework for River Basin Institutions is not yet finalised.

Secondly, the SADC Water Protocol is based on the Helsinki Rules. Inherent within this set of rules is the concept of equitable use of the waters in shared river systems. This implies that the potential for conflict is somewhat reduced, while enhancing the likelihood of co-operation.

Thirdly, by devolving the responsibility down to each riparian state, SADC is allowing those with the most pressing needs to come forward and take leadership. This is being done, and there is a direct correlation between states that have a pressing need to expand their water resources and this leadership role. These states are found in the "Central Belt of Resource Scarcity". In the case of the Zambezi Basin hegemon, Zimbabwe, it has taken the lead to establish a basin-wide regime. This is based on the expansion of the ZRA, a structure that it already dominates. In the case of the regional hegemon, South Africa, it has taken the lead in developing International Law relating to the use of shared river basins in terms of the White Paper on Water Policy. In addition to this, South Africa has placed the priority for meeting international obligations for downstream riparians just behind the so-called "Reserve" (basic human needs and the minimum needs of the aquatic ecosystem in order to survive). This means that international agreements have a higher priority than local consumers do, after basic survival has been ensured. Significantly, both Zimbabwe and South Africa have been identified during this research as being the most important hydropolitical actors on the demand side of the hydropolitical equation. Botswana, the state identified as a potential "balancer of regional hydropolitical power" has also accepted the SADC Protocol as the basis for renewed bilateral talks with Zimbabwe over the Ramokgwebana River.

An important aspect about the SADC Water Protocol in terms of the hypothesis is that it is the first SADC Protocol to be adopted. This indicates the priority that co-operation in the water field has within a regional context.

Finally, South Africa recognises the potential that regional trade has for addressing the water needs of states in arid climates. The principles on which the White Paper are based, including the recognition of the sectoral water efficiency of industry compared to agriculture, regional trade, sustainability and co-operation, are all fundamental to the concept of 'virtual water'. The White Paper even goes so far as to call for additional research into the use of regional trade to balance the water shortages in a Southern African context. It can therefore be said that the concept of 'virtual water' is compatible with the South African policy and is also compatible with the SADC Water Protocol.

The Second Hypothesis

The second hypothesis is that functional co-operation in the study area in common issue-areas such as population growth and migration, agricultural capacity and spatial development, is correlated to functional co-operation in shared water resource management.

This research has shown that water scarcity is directly linked to population growth. Population control policy is thus a logical area for future political 'interaction'. This is not evident in the SADC Water Protocol however. Significantly, it is also absent from the White Paper on Water Policy for South Africa. This is seen as a weakness in both documents as a result of the fact that the water scarcity is population-induced. In other words, population policy ought to be the subject of further interaction, preferably resulting in a SADC Protocol on Population Development. If this is not done, then the long-term benefits of the Water Protocol will ultimately fail to prevent the water scarcity from getting worse.

Regarding regional co-operation in terms of agriculture, there is evidence that Botswana and South Africa have recognised the need for this. This is encouraging and is in keeping with the 'virtual water' development strategy, which recognises the need to forego the desire for national self-sufficiency in food in favour of a regional food-security approach. By definition then, a 'virtual water' agricultural strategy will result in a natural co-operative dynamic within a regional context based on a win-win approach. It has been shown that states that function within a supply side policy paradigm tend to view agricultural self-sufficiency as a major priority. This results in increased competition for water and leads to in the misallocation of scarce water to an economic activity that is known to have a low 'return to water'. In other words, a strictly supply sided approach impacts directly on water scarcity and exacerbates the problem. Such an approach is also based on the fundamental dynamic of a zero-sum principle and is thus conducive to conflict.

Regarding spatial development, South Africa has acknowledged via the GEAR that increased trade within SADC is needed. This could become the impetus for a more spatially balanced economic development pattern. The research indicated that a two-tiered approach would probably be appropriate. The first tier would be to encourage trade *within* the SADC grouping by giving preference to products containing a high 'virtual water' content. This would mean that states such as Angola and Zambia could make their products available to the regional market, and that these states should even be protected in order to ensure their initial viability, given their severely depleted economies at present. This first tier is thus seen as a logical step towards solving the water scarcity problems, and if adopted, can also start to address the problems of poor intra-regional trade that tend to plague SADC. An initial step towards the implementation of this first tier is for SADC to introduce an Agricultural Protocol.

In keeping with the theme of spatial development, a 'virtual water' approach is compatible with balanced development within a regional context. In this case, both Angola and Zambia have significant agricultural potential. What they lack is the technology, infrastructure and financial support to make this viable. More developed states such as South Africa and Zimbabwe could thus assist by providing these missing elements as it would be to their direct advantage. This can be addressed in the proposed Agricultural Protocol.

There is thus evidence that increased 'interaction' is inevitable, as all states are linked to the common problem of water scarcity in the study area. In this respect, the proposed Agricultural Protocol is seen as a step towards a SADC Industry Protocol as it is known that industry uses less water and creates more livelihoods.

It can be seen that by adopting a 'virtual water' development strategy at a regional level, there will be a natural propensity for 'enmeshment' and 'interaction'. This is due to the fundamental logic that local economies are subordinate to regional economies, which in turn are subordinate to global economies. South Africa, as the regional hegemon, can take the lead in launching these diplomatic initiatives starting from the SADC Water Protocol.

The Third Hypothesis

The third hypothesis is that reliance on a national policy for food self-sufficiency does correlate to a low Sectoral Water Efficiency for agriculture in the majority of the states in the study area.

In this regard there were problems experienced during the research regarding the availability of data in order to determine the agricultural SWE. In general two data sets were available. It would have been much better for the ultimate conclusion if a longer data sequence could have been used. In some cases the data for the two sets were far removed from each other, resulting in an anomaly. This was the case for Botswana, Malawi and Zambia for example. In other cases the two data sets were similar, resulting in a more conclusive result. This was the case for Zimbabwe, South Africa and Angola.

There are thus two problems that need to be highlighted. This first is that regarding data availability. Given the fact that the White Paper on Water Policy has recognised the fact that agriculture tends to be less efficient in terms of SWE, this will have to be quantified in greater detail in future. Significantly, when the author was presenting a paper at the Eighth South African National Hydrology Symposium on 17-19 November 1997, representatives of both the Department of Water Affairs and Forestry and the Development Bank of Southern Africa were in agreement on this aspect. They went so far as to suggest that this should become a SADC project. Institutions such as the Water Research Commission could thus become involved in the establishment of a regional database to meet this need. Unfortunately the reality at this time is that the author could not locate better data and this impacts on the research.

The second problem is that regarding the norms which were used. The author arbitrarily set these as no previous research had been done using these concepts. Clearly there is room for refinement. It is difficult to define exactly what constitutes a high, medium or low SWE. This research can thus be seen as being a step in a new direction. This is the start of a journey and certainly cannot be seen to be the end of that journey. The author is intending to continue with this research direction, and will give specific attention to the refinement of these parameters in future.

As limited as the data sets were, they did show that agriculture tends to have a lower SWE than industry. For example, in 1995, agriculture in Zimbabwe consumed 79% of the water and contributed only 14% to the GDP; compared with industry that consumed 7% of the water while contributing 30% to the GDP during the same year. In the case of South Africa, in 1995, 72% of the water consumed by agriculture contributed only 6% to the GDP; whereas industry consumed only 11% while contributing 30% to the GDP for the same year. This trend is evident in almost all states in the study area.

In this regard the rationale of a 'virtual water' development strategy is clearly supported. It is encouraging to note that the White Paper on Water Policy for South Africa recognises this.

The states that have been driven by the persistent desire to achieve national self-sufficiency in agriculture are also in need of gaining access to more water. Fortunately, both Botswana and South Africa have recognised that it is this desire for self-sufficiency, which exacerbates the water shortage problem and both have changed their policy stance. Unfortunately Zimbabwe seems to be locked into this self-sufficiency paradigm.

The Fourth Hypothesis

The fourth hypothesis is that under inherently arid conditions in which the Sectoral Water Efficiency for industry is higher than that of agriculture, a 'virtual water' based policy would manage the water scarcity problems, and achieve economic growth and diversification.

In this regard the research result was somewhat disappointing. Due to the limited data sets available, specifically for the industrial SWE, there can be no conclusive proof provided that the hypothesised condition exists. What can be said however, is that the data used, as limited as it was, generally tended to support the hypothesis. The case of South Africa is illuminating in this regard. Industry consumed 11% of the water while contributing 45% to the GDP in 1980; industry consumed 13% of the water while contributing 31% to the GDP in 1990; and industry consumed 11% of the water while contributing 30% to the GDP in 1995. (The reader is referred to Table 51 for more details). This was significantly better than agriculture for the same years. A similar trend (but for a one-year data sequence only) is evident in Zimbabwe and elsewhere.

Two things need to be said about the industrial SWE. Firstly, as in the case of agriculture, the data availability was limited. This was unfortunate but could not be prevented. Secondly, as in the case of agriculture, the norms were somewhat arbitrarily defined. What is encouraging about the industrial SWE is that while the above problems were encountered, there was still a strong indication that the hypothesised condition prevailed. Industry was more efficient than agriculture at converting water into GDP contribution in most cases. This was consistently evident in the limited data sets used. This is supportive of the 'virtual water' development strategy that has been proposed.

The research has highlighted one very important aspect however. In order for 'virtual water' to become the solution, a state needs to purchase commodities with a high 'virtual water' content. Given the prevailing aridity in the study area, the likelihood for purchasing sufficient 'virtual water' within SADC is limited. This in turn implies that 'virtual water' will have to be purchased from the global market and paid for in hard currency. Two things thus become relevant to this discussion.

Firstly, a 'virtual water' development strategy implies that there must be sufficient industrial development within a state to fund the purchases. In the study area this is problematic. The strongest economy, South Africa, is not globally competitive as the result of years of isolation. Zimbabwe, the second most diversified economy, is also non-competitive, having based its industrial strategy on import substitution. This general trend was evident throughout the study area and will probably act as a severe constraint for a 'virtual water' development strategy.

Secondly, a 'virtual water' development strategy implies moving away from a paradigm of national self-sufficiency towards a paradigm of co-operation in a regional context. Of significance, the SADC Water Protocol represents a step in this direction, with two of the key players, South Africa and Botswana, having made the policy shift in the right direction. The third big player, Zimbabwe, has shown no sign of following suite however.

For these reasons, a deliberate regional strategy will be needed. This strategy will have to be based on the understanding that competition for global trade can be as destructive as competition for water. In this sense, a two-tiered approach is suggested as being the most appropriate. The first tier involves stimulating trade *within* SADC, by giving preference to 'virtual water' rich commodities that can be produced in Angola and Zambia. Tariff protection and guarantees can be given where needed until the production is viable in its own right. This can become the rationale for spatial redistribution to those two states and can easily be supported by the other major players as it is to their own advantage. This intra-regional 'virtual water' trade is unlikely to balance the water shortages in total. The second tier thus becomes necessary, where trade is encouraged *outside* the region. This is the current trading pattern, but is to be shifted to the second tier of the strategy in order to elevate the weak intra-regional trade patterns that plague the study area as a higher priority. South Africa, as the hegemonic power in the region, seems to be committed to this new direction and can take the lead.

A deliberate attempt will have to be made to balance the spatial inequalities, as their continued existence will result in population migration from the "Eastern Belt of Poverty" to the "Central Belt of Resource Scarcity", further exacerbating the problems of water scarcity in those target states.

The less diversified the economy is, the less potential benefit can be derived from a 'virtual water' strategy. It is therefore concluded that 'virtual water' as a concept has a lot of merit and that it could solve the water scarcity problems of political economies in arid regions *provided they have a degree of industrial diversity in the first place.* Taking this logic further, it can be concluded that states such as those found in the "Western Belt of Resource Abundance" that have a high level of resource availability, but a low level of economic development, would therefore benefit directly from such a regionally applied development strategy. The case of Batoka Gorge versus Kafue 3 provides an example. If Kafue 3 were built, it would benefit Zambia more than the Batoka Gorge Project. In addition to this, Kafue 3 would have a lower environmental impact and provide a more economical solution that Batoka Gorge would. In regional terms, Kafue 3 is therefore a better option, but this would disadvantage Zimbabwe, as the latter tends to view the problem in terms of a zero-sum game. The gain of Zambia (and the region) would thus be seen to be Zimbabwe's loss by Zimbabwe. The challenge therefore becomes to shift the pattern of interaction away from the zero-sum paradigm, to the more harmonious win-win approach that is inherent within a regional co-operative model. The normative system apparent within the White Paper on Water Policy does this and needs to be infused into the regional dynamics in order to achieve the desired shift.

Synthesis of Conclusions Reached

It is appropriate to discuss how the author views the current manner in which the policy-makers approach the problem of water scarcity. Presented in Figure 27 is a schematic representation of the research findings regarding the way the current problem of water scarcity is being viewed within SADC.

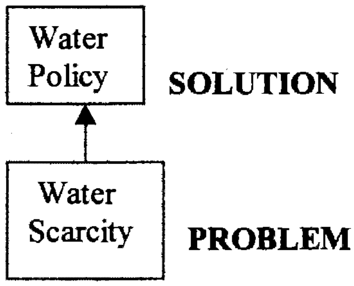


Figure 27. Schematic representation of the way that policy-makers view the current water scarcity problem.

From this simplified diagram, it can be seen that the problem of water scarcity in the study area tends to be viewed by policy-makers in simplistic form at present. The overall problem of the water scarcity (first subproblem) is being addressed by a water policy in each state, or at regional level, by means of the SADC Water Protocol. Nowhere is the issue of population growth (second subproblem) addressed in current water policy. The problem with this approach is that it is too simplistic as it simply ignores the major root causes of the water scarcity. The current research has attempted to identify the impact that population growth (second subproblem) has on water scarcity. The research has shown that population growth (second subproblem) is causally related to water scarcity and therefore needs to be factored into the water policy, if the latter is to succeed in the long-term. The research has also shown that the sectoral allocation of water impacts on water scarcity. What is therefore needed is to expand the view of the problem area in order to gain better perspective. This is done in Figure 28.

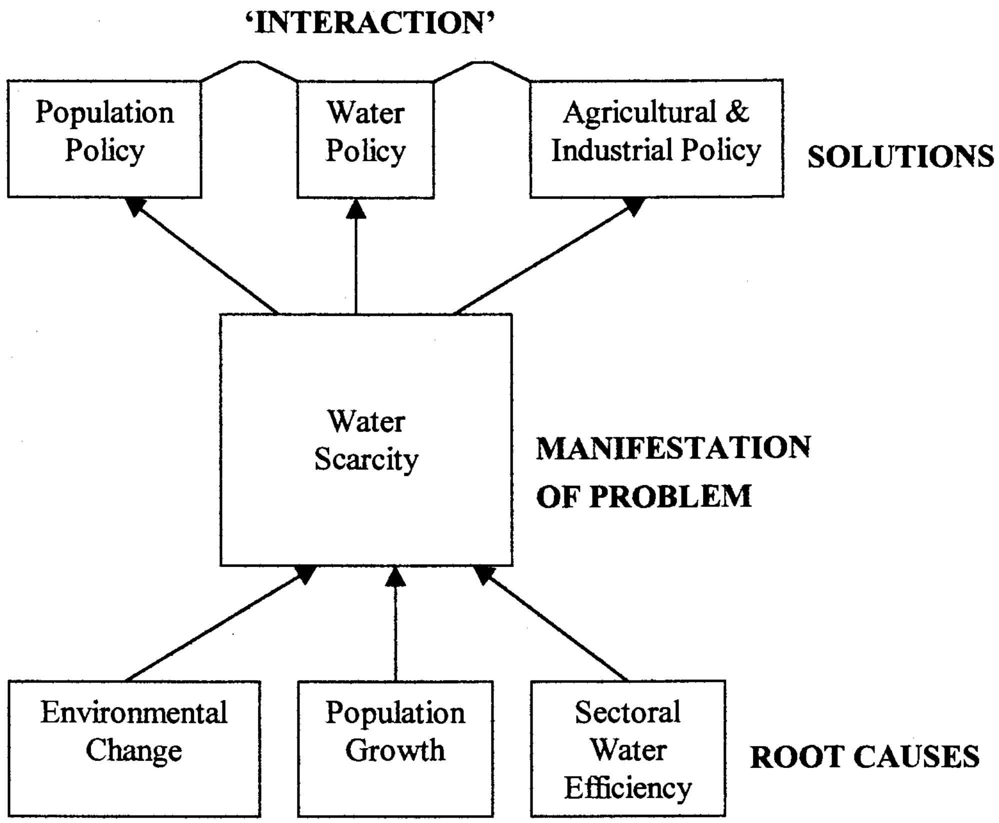


Figure 28. Schematic representation of the actual root causes of the problem and consequent solutions that ought to be considered by policy-makers.

This expanded view of the problem of water scarcity places the various components into a correct perspective. The problem of water scarcity really has three root causes, which need to be fully understood, as each impact on the problem. The first root cause is environmental change. As noted earlier this problem is beyond the scope of the current research. The second root cause is population growth (second subproblem). This has been clearly shown in the research to be a major cause of water scarcity and therefore needs to be addressed in policy. The third root cause is that of sectoral water efficiency (third and fourth subproblems). The research has shown that in most states in the study area, agriculture consumes vast proportions of the water budgets of the state in question, while generally contributing only a small portion to the overall GDP of that state. Industry on the other hand, tends to consume less water while contributing more substantially to the overall GDP. This misallocation of water within an economy is as significant a cause of water scarcity as population growth and climate change is, and needs to be factored into the policy solution.

This expanded view of the problem therefore sees 'water scarcity' as a manifestation of a problem, rather than the problem itself. It thus seeks to place in perspective, the relevant policy interventions that ought to be considered by policy-makers. This is not currently evident in the study area, so this is where the probable 'spill-over', 'enmeshment' or 'interaction' is likely to occur between the states that have been studied. It is logical that if the expanded view of the problem of water scarcity is adopted, then the way forward is clearly to start to address the population problems by means of a SADC Population Protocol, as a fundamental step in the right direction. This is a politically sensitive issue however and deserves additional research. The next logical step therefore becomes an Agricultural and/or Industrial Protocol within SADC, as this will also address one of the key root causes of the problem of water scarcity, by improving the way in which water is allocated to an economic activity on a regional basis.

Figure 29 shows how the proposed two-tiered strategy could be used as a starting point for addressing the water scarcity problem that is caused by sectoral inefficiencies within the study area. A 'virtual water' strategy dictates that trade within the region should be fostered in order to balance the water budget.

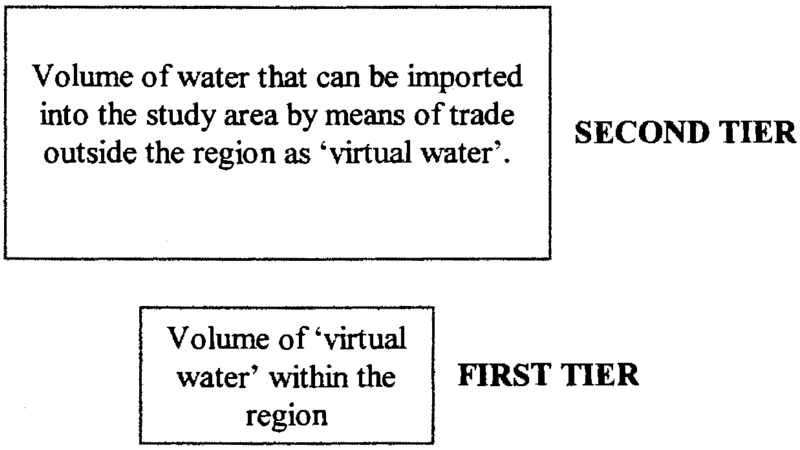


Figure 29. Schematic representation of the start of the proposed two-tier strategy for balancing the water budget within the study area.

As can be seen from Figure 29, the volume of 'virtual water' that can be mobilised within the study area is initially small. This is due to the fact that the major potential 'virtual water' exporters (Zambia and Angola) are economically underdeveloped. They have significant potential however, and if a 'virtual water' development strategy is implemented by SADC, it can be used to kick-start those economies. This would be mutually beneficial to both the "Western Belt of Resource Abundance" and the "Central Belt of Resource Scarcity" in terms of mobilising scarce water resources. It can also be used to balance the current spatial and trade imbalances that exist within the region.

The long-term goal of this two-tiered approach is represented in Figure 30. As can be seen, the volumes of 'virtual water' traded will have shifted, as the relative economies within each state in the study area will have grown, due to the improved state of intra-regional trade.

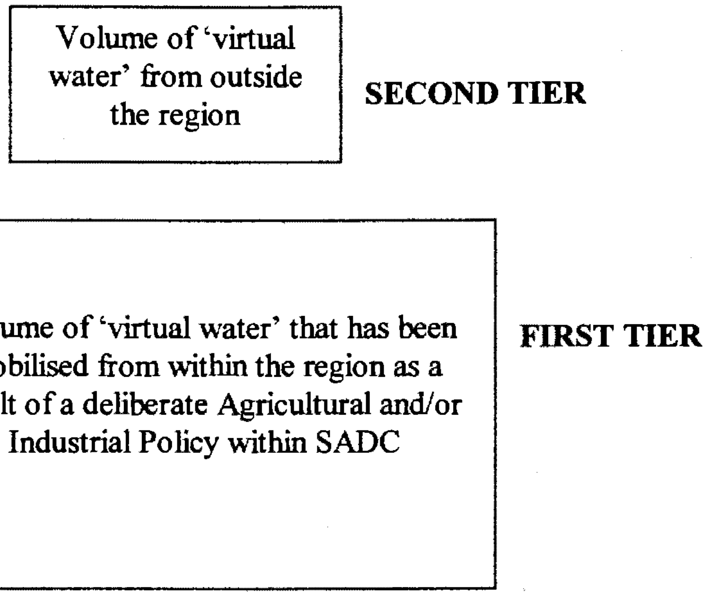


Figure 30. Schematic representation of the long-term goal of the proposed two-tier strategy for balancing the water budget within the study area.

From this it can be seen that 'virtual water' as a development strategy can be used firstly to balance the regional water inequalities that exist; and secondly to stimulate the weaker economies by promoting and fostering intra-regional trade.

Additional Research

Falkenmark's WBS and WSI

These concepts have proven to be useful during this study. The only problem is the lack of accurate population statistics. The WBS and WSI proved to be of value in determining the HPRP of a given state. It was considered to be significant that the HPRP profile tended to be reflected in other hydropolitical manifestations. For example the higher HPRP cases all manifest a degree of commitment to gaining access to water by funding water related projects on an ever-increasing scale. Additional research would thus be encouraged, specifically where accurate population projections could be factored into the WBS and WSI scales in order to answer "what if" types of question. Such research could show the result of a higher than expected population growth rate for Malawi as an example. It could also show what the result for South Africa would be if it could control population growth and illegal cross-border migration better than at present.

Allan's Concept of 'Virtual Water'

It is highly relevant that the White Paper on Water Policy for South Africa is consistent with Allan's concept of 'virtual water'. This is encouraging indeed. It would be of great value to quantify the potential for regional trade in 'virtual water', as this was not accomplished during this study. Such research should try to establish a regional water budget as a starting point, and then go on to determine how much of the deficit could be met by trading 'virtual water' within the region.

Another area of research interest would be to determine the exact developmental trajectory in terms of the Karshenas Model that states like Malawi, Tanzania and Mozambique are likely to have in future. In this regard it has been hypothesised by the author that policy intervention may be insufficient to prevent an ecological catastrophe for these states. Outside assistance will be needed to avert such a disaster if this hypothesis is valid, because this environmentally induced collapse would have major regional implications.

An area of the current study that was weak, was that portion of the research that relied on the SWE analysis. There was a general paucity of data in this regard, so the best available was used. Even with this weakened database, there was a consistent pattern evident, so the concepts are still considered to be valid. More accurate sectoral water consumption statistics for the various states would be of great value, especially if they covered a time sequence. These would enable a more dynamic and accurate picture to be built up over time, which in turn could result in a better analysis of the impact of a policy change. The Water Research Commission can play a major role in this regard.

Lowi's Theory of Hegemonic Co-operation

This theory proved to be of value in terms of providing an explanatory element to the hydropolitical model that was generated. Both Zimbabwe and South Africa seem to be showing the type of behaviour that is consistent with their hegemonic status. As noted before, Zimbabwe is the hegemon in the Zambezi Basin, and as such is taking the lead in regime creation. Evidence has been presented that Zimbabwe views matters in terms of a zero-sum game and thus views other actors as competitors. This is in keeping with

Lowi's theory. If the unit of analysis is expanded beyond the Zambezi Basin, then South Africa becomes the hegemon. South Africa is clearly actively involved in regime creation via the development of International Law. The White Paper provides strong evidence of a co-operative stance away from the zero-sum principle. Significantly, South Africa stands to gain the most from this approach. Lowi's theory thus seems to have a *degree* of validity.

Where Lowi's theory is not consistent with Southern African hydropolitics is surrounding the fact that there is not the same pattern of intense hostility in Southern Africa as that evident in the Middle East. Aspects relating to "high" and "low" politics are thus not as evident in Southern Africa. Lowi's theory assumes that hydropolitical opponents are the "enemy" and is based on the fundamental issue of "relative gains". In the study area this was not universally manifest. Possibly Zimbabwe sees things in this light, but South Africa certainly does not. This is where Lowi's theory is weak and thus cannot be used with confidence in a Southern African context.

There is a need to develop a stronger theoretical basis for understanding the hydropolitical dynamics of Southern Africa in future. In this regard Lowi's work can be considered to be a point of departure. Unfortunately the author could locate no other theoretical basis at the time of doing the research. There is thus a pressing need to develop this theory further.

Closing Remarks

The concept of 'virtual water' has merit within a Southern African context and could become a useful tool regarding policy development. The regional political dynamics are currently seen to be in a state of transition that enables this issue to be more adequately assessed. Firstly, Southern African political dynamics have been changed as a direct result of the process of democracy that has taken place in South Africa. This means that whereas before South Africa was excluded from structures such as SADC, it is now increasingly being looked to as a potential leader. Secondly, drought can be seen as both a catastrophe and an opportunity. It is an opportunity in the sense that it enables the debate about water allocation to be opened up. This was the case in Israel and has also been the case in South Africa immediately prior to the White Paper. Given the known cyclicity of droughts in Southern Africa, water policy planners can look forward to the next round of droughts to propagate their regionalistic views.

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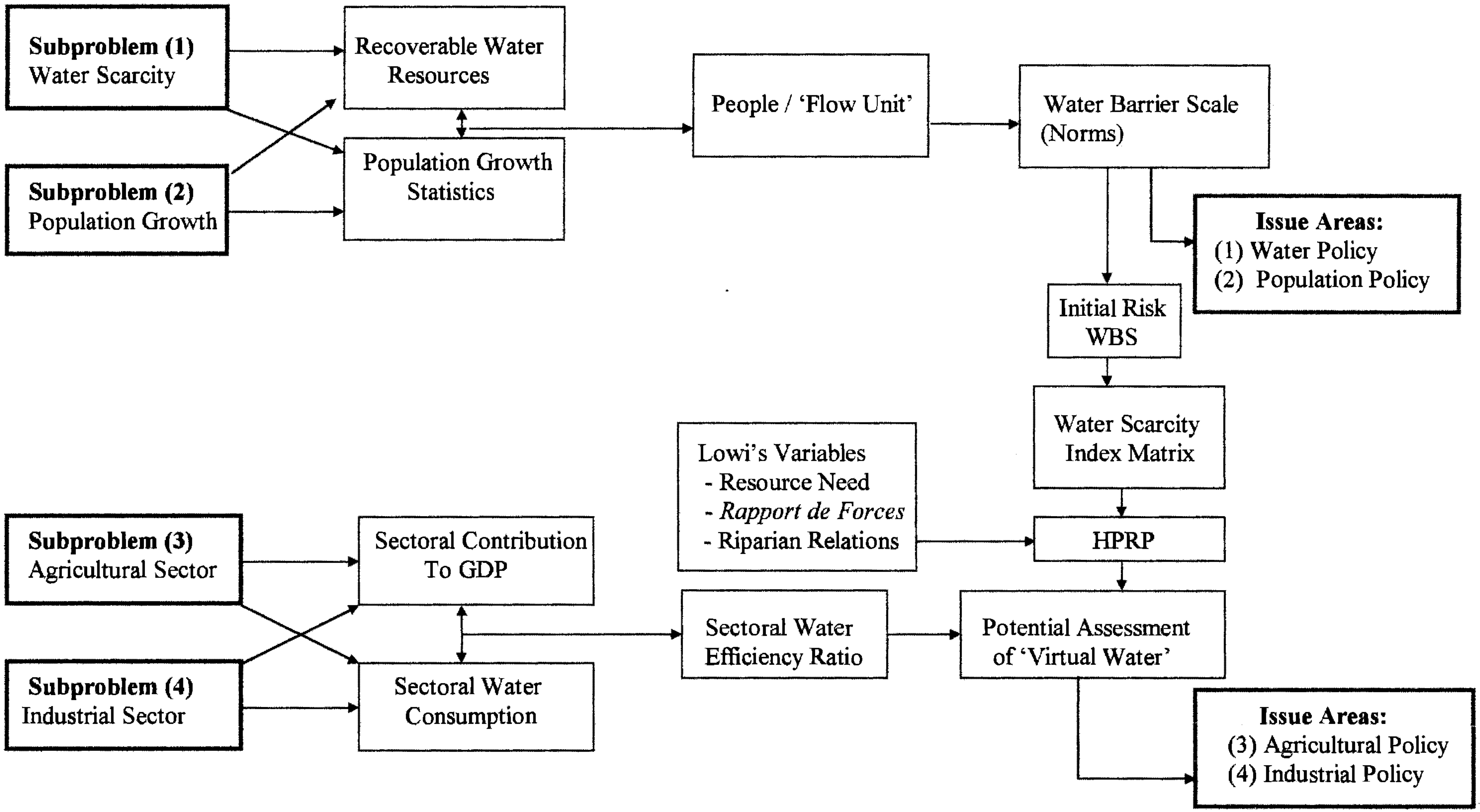
APPENDIXES

RESEARCH METHODOLOGY FLOW CHART **APPENDIX "A"**



Appendix "B"

Table of Combined Statistics Linking
Falkenmark's Water Scarcity Index and Water Barrier Scale for SADC Countries
(Reproduced from Falkenmark, 1989:113; MacDonald *et al.*, 1990a:2-28; Arnestrand *et al.*, 1993:24; and Ohlsson, 1995a:48)

Country	**Population** (millions)				**Recoverable resources** of water (km^3 / y^{-1})	**Water Barrier Scale** (persons per 'flow unit' of one million m^3 / y^{-1}) Level of water competition			**Water Scarcity Index** (from Appendix "D")		
	1982	**1990**[1]	**2000**	**2025**		**1982**	**2000**	**2025**	**1982**	**2000**	**2025**
Angola	7,43	13,2	13,2	24,5	158	47	84	160	11	11	12
Botswana	0,86	1,87	1,87	4,06	9	96	210	450	11	22	22
Malawi	6,57	11,7	11,7	23,2	9	730	1300	2600	13	24	25
Mozambique	11,1	21,8	21,8	39,7	58	190	380	690	12	12	23
Namibia	1,07	2,38	2,38	4,29	9	120	260	480	22	32	32
South Africa	-	35,2[1]	-	63,2[1]	50[2]	('90) 741[2]	-	1419[2]	('90) 33[2]	-	34[2] (44[1])
Tanzania	19,1	26,8	26,8	52,3	76	250	520	1100	12	22	24
Zambia	6,16	11,2	11,2	23,8	96	60	120	250	11	12	12
Zimbabwe	7,93	15,1	15,1	32,7	23	350	660	1400	12	23	24

Note: Figures denoted by the symbol [1] are from Arnestrand *et al.*, 1993:24 (and which give 1990 figures identical to Falkenmark's 2000 figures) and [2] are from Ohlsson, 1995a:48. All other significant figures correlate with Falkenmark's however.

Appendix "C"

Conversion Chart
from
Volume of Water (M^3) / P / Yr^{-1}
to
Number of People / 'Flow Unit' (one million M^3 / Yr^{-1})

Showing Falkenmark's 'Water Barrier Scale'
and Gustafsson's 'Subsistence Level'.

M^3 / P / Yr^{-1}			People / 'Flow Unit'	
25 000			40	
22 222			45	
20 000	Well Watered	Code 1	50	
13 333			75	
10 000			100	
8 000			125	
4 000	Mid European Conditions	Code 2	250	
2 000			500	
1 666			600	
1 250	Water Stressed	Code 3	800	Gustafsson's 'subsistence level'
1 000			1 000	
666	Chronic Scarcity	Code 4	1 500	
500			2 000	'Water Barrier'
454			2 200	
416	Beyond 'Water Barrier'	Code 5	2 400	
384			2 600	
357			2 800	
333			3 000	

Appendix "D"

Falkenmark's Water Scarcity Index Matrix

(Reproduced from Falkenmark 1989:116; Arnestrand *et al.*, 1993:23; and MacDonald *et al.*, 1990a:2-26)

Needed yield increase for self-sufficiency (rainfed agriculture) expressed as level of technology	Code	**Water Competition Level (People / 'Flow Unit' (one million M^3 water / Yr^{-1})** <100 Well Watered **1**	100 - 600 Mid European **2**	600 - 1 000 Water Stressed **3**	1 000 - 2 000 Chronic Scarcity **4**	> 2 000 Beyond 'Water Barrier' **5**
Low level enough	**1**	11	12			
Intermediate level enough	**2**	21	22	23	24	25
High level enough	**3**	31	32	33	34	35
Large scale irrigation needed	**4**		42	43	44	45

Abundant

Scarcity

Food / water crisis

Severe problems

Mainly quality and dry season problems

'Water Barrier' under advanced technological conditions

Appendix "E"

SADC Agreements in Existence Pertaining to Water Resources

NAME	YEAR	STATES	CONTENT	ASSESSMENT
ANJCC Angolan-Namibian Joint Commission of Co-operation	1990	Angola Namibia	Umbrella institution with a large number of issues including water	Functional
PJTC Permanent Joint Technical Commission	1990	Angola Namibia	Cunene River Basin, primarily responsible for the Epupa Dam hydroelectric power scheme	
JCA Joint Operating Authority	1990	Angola Namibia	Operation of regulation dame at Gove and Ruacanà	Functional
OKACOM Permanent Okavango River Basin Water Commission	1994	Angola Botswana Namibia		Newly functional
LBPTC Limpopo Basin Permanent Technical Committee	1986	Botswana Mozambique South Africa Zimbabwe		Not functioning well; needs revival
JPTC Joint Permanent Technical Committee	1989	Botswana South Africa	Limpopo River and tributaries up to the confluence of the Shashe and Limpopo Rivers	
JPWC Joint Permanent Water Commission	1990	Botswana Namibia	Development of common water interests particularly the Okavango, Cuando-Linyati-Chobe River systems	Functional
JPTC Joint Permanent Technical Commission	1986	Lesotho South Africa	Advisory and monitoring capacity of Lesotho Highlands Water Project (LHWP)	

LHDA Lesotho Highlands Development Authority	1986	Lesotho	Parastatal subordinate to JPTC responsible for LHWP in Lesotho	Functioning well
TCTA Trans-Caledon Tunnel Authority	1986	South Africa	Parastatal subordinate to JPTC responsible for LHWP in South Africa	Functioning well
JCC Joint Commission of Co-operation	1992	Malawi Tanzania	Umbrella institution; does not mention water specifically	Malfunctioning
PCC Permanent Commission of Co-operation	1982	Malawi Zambia	Umbrella institution; does not mention water specifically	Malfunctioning
PJCC Permanent Joint Commission of Co-operation	1984	Malawi Mozambique	Umbrella institution; does not mention water specifically	Malfunctioning
JPTWC Joint Permanent Technical Water Commission	1991	Mozambique Swaziland	Technical advisor on water matters of common interest	Malfunctioning
JPTC Tripartite Permanent Technical Committee	1983	Mozambique South Africa Swaziland	Joint water schemes on Limpopo, Incomati and Maputo	Malfunctioning
Permanent Water Commission (Orange)	1992	Namibia South Africa	Orange River basin	Functions satisfactorily and is under discussion between riparians
JIA Joint Irrigation Authority	1992	Namibia South Africa	Established by the Treaty of Vioolsdrift and Noordoewer Joint Irrigation Scheme (VNJIS) on both banks of the Orange River	Functions well
KOBWA Komati Basin Water Authority	1991	South Africa Swaziland	Komati River Basin Development Project	

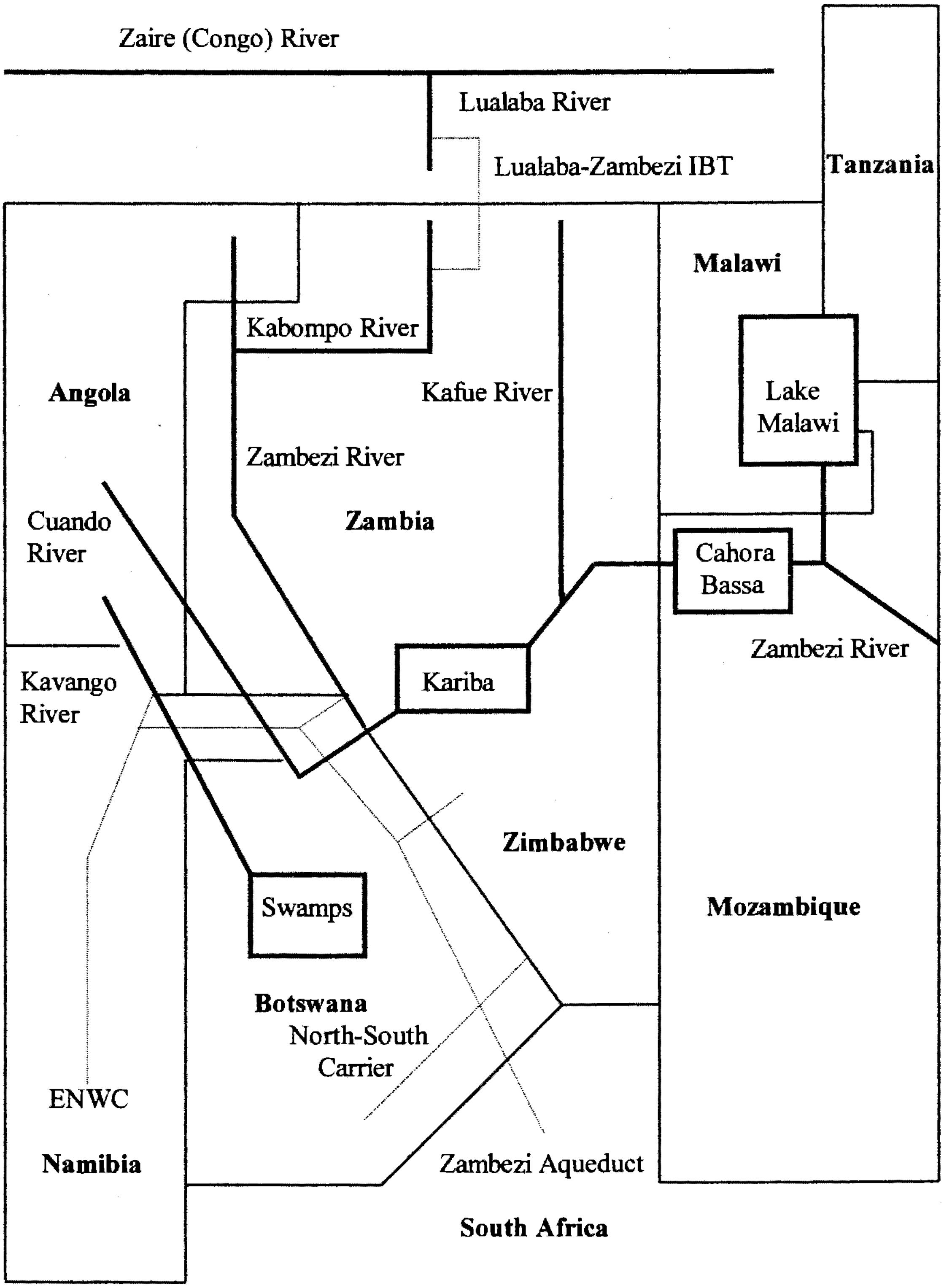
ZRA Zambezi River Authority Council	1987	Zambia Zimbabwe	Hydroelectric facilities at Kariba and planning of Batoka Gorge	Currently under discussion between riparians
SARCCUS Southern African Regional Commission for the Conservation and Utilisation of the Soil	1948	Angola Botswana Lesotho Malawi Mozambique Namibia South Africa Swaziland	Ten standing committees, one of which is for Water Resources; deals with a wide spectrum of water related matters	Water Committee very active
SADC Southern African Development Community	1992		Water matters falls under the Food, Agriculture and Natural Resources Sector, based in Harare, Zimbabwe	

Source: Manuscript draft to SIDA by P. Heyns, Department of Water Affairs, Namibia (Ohlsson, 1995a:59-60)

In addition to the above the following are signatories to the Protocol on Shared Watercourse Systems in the Southern African Development Community (SADC) Region: Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe.

Appendix "F"

Hydropolitical Map of the Zambezi Basin



Appendix "G"

Fundamental Principles and Objectives for a new Water Law for South Africa

Extract from the White Paper on Water Policy (DWAF, 1997)

Principle 1

The water law shall be subject to and consistent with the **Constitution** in all matters including the determination of the *public interest* and the rights and obligations of all parties, public and private, with regards to water. While taking cognisance of existing uses, the water law will actively promote the values enshrined in the **Bill of Rights**.

Principle 2

All water, wherever it occurs in the *water cycle*, is a resource common to all, the use of which shall be subject to national control. All water shall have a consistent status in law, irrespective of where it occurs.

Principle 3

There shall be *no ownership of water* but only the right (for environmental and basic human needs) or an authorisation for its use. Any authorisation to use water in terms of the water law shall not be in perpetuity.

Principle 4

The location of the water resource in relation to land shall not in itself confer preferential rights to usage. The *riparian principle* shall not apply.

Principle 5

In a relatively arid country such as South Africa, it is necessary to recognise the unity of the *water cycle* and the interdependence of its elements, where evaporation, clouds and rainfall are linked to groundwater, rivers, lakes, wetlands and the sea, and where the *basic hydrological unit is the catchment.*

Principle 6

The variable, uneven and unpredictable distribution of water in the *water cycle* should be acknowledged.

Principle 7

The *objective* of managing the quantity, quality and reliability of the nation's water resources is to achieve optimum, long-term, *environmentally sustainable social and economic benefit* for society from their use.

Principle 8

The water required to ensure that all *people* have access to sufficient water shall be *reserved.*

Principle 9

The quantity, quality and reliability of water required to maintain *ecological functions* on which humans depend shall be *reserved* so that the human use of water does not individually or cumulatively compromise the long-term sustainability of aquatic and associated ecosystems.

Principle 10

The water required to meet the *basic human needs* referred to in Principle 8, and the *needs of the environment*, shall be identified as the *Reserve* and shall enjoy priority of use by right. The use of water for all other purposes shall be subject to authorisation.

Principle 11

International water resources, specifically *shared river systems*, shall be managed in a manner that optimises the benefits for all parties, in a spirit of mutual co-operation. *Allocations agreed for downstream countries shall be respected.*

Principle 12

The National Government is the custodian of the nation's water resources, as an indivisible national asset. Guided by its duty to promote the *public trust*, the National Government has ultimate responsibility for, and authority over, water resource management, the *equitable allocation and usage of water* and the *transfer of water between catchments and international water courses.*

Principle 13

As custodian of the nation's water resources, the National Government shall ensure that the development, apportionment, management and use of those resources is carried out using the *criteria of public interest, sustainability, equity and efficiency* of use which reflects the public trust obligations and the value of water to society while ensuring that basic domestic needs, the requirements of the environment and international obligations are met.

Principle 14

Water resources shall be developed, apportioned and managed in such a manner as to enable all user sectors to gain equitable access to the desired quantity, quality and reliability of water. Conservation and other *measures to manage demand shall be actively promoted* as a preferred option to achieve these objectives.

Principle 15

Water quality and quantity are interdependent and shall be managed in an integrated manner, which is consistent with broader *environmental management approaches.*

Principle 16

Water quality management options shall include the use of economic incentives and penalties to reduce pollution; and the possibility of irretrievable environmental degradation as a result of pollution shall be prevented.

Principle 17

Water resource and supply activities shall be managed in a manner that is consistent with the broader national approaches to *environmental management.*

Principle 18

Since *land uses* have a significant impact upon the *water cycle*, the regulation of land use shall, where appropriate, be used as an instrument to manage water resources within the broader integrated framework of land use management.

Principle 19

Any *authorisation to use water* shall be given in a timely fashion and in a manner which is clear, secure and predictable in respect of the *assurance of availability, extent and duration of use.* The purpose for which the water may be used shall not arbitrarily be restricted.

Principle 20

The conditions upon which *authorisation* is granted to use water shall take into consideration the *investment made by the user* in developing infrastructure to be able to use the water.

Principle 21

The development and management of water resources shall be carried out in a manner which limits to an acceptable minimum the *danger to life and property* due to natural or manmade disasters.

Principle 22

The *institutional framework* for water management shall as far as possible be simple, pragmatic and understandable. It shall be self-driven and minimise the necessity for State intervention. Administrative decisions shall be subject to appeal.

Principle 23

Responsibility for the development, apportionment and management of available water resources shall, where possible and appropriate, be delegated to a *catchment or regional level* in such a manner as to enable interested parties to participate.

Principle 24

Beneficiaries of the water management system shall contribute to the *cost* of its establishment and maintenance on an equitable basis.

Principle 25

The right of all citizens to have *access to basic water services* (the provision of potable water supply and the removal and disposal of human excreta and wastewater) necessary to afford them a healthy environment on an equitable and economically and environmentally sustainable basis shall be supported.

Principle 26

Water services shall be regulated in a manner that is consistent with, and supportive of, the aims and approaches of the broader local government framework.

Principle 27

While the provision of water services is an activity distinct from the development and management of water resources, water services shall be provided in a manner consistent with the *goals of water resource management.*

Principle 28

Where water services are provided in a monopoly situation, the *interests of the consumer* and the wider public must be protected and the broad goals of public policy promoted.