How do states manage water stress? What are the experiences in Southern Africa and the Middle East? How can decision makers be supported in the future? These are some of the questions covered in this study, the outcome of ESCOR Small Grants Research Project R7647. Compiled by a team of researchers from both north and south, the study provides a route through the complex decision-making that is required to manage adjustment to water scarcity in uncertain, risk-prone environments. The answers are not always obvious – and invariably complex. Solutions may have to be found outside the water sector in the form of 'virtual water' imports, yet still have to balance the national and local concerns of livelihood sustainability and poverty reduction. To achieve more effective, systematic decisions in these environments, FoRWaRD – a decision support model – is presented by the authors. Comments and feedback are welcome and should be sent to both aturton@csir.co.za and a.nicol@odi.org.uk.

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Policy options in water-stressed states:

Emerging lessons from the Middle East and Southern Africa

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Contents

Acknowledgements

This report was compiled from contributions made by Professor Tony Allan (School of Oriental and African Studies, University of London), Anthony Turton (African Water Issues Research Unit, University of Pretoria and GIBB-SERA Chair in Integrated Water Resource Management) and Alan Nicol (project leader, Overseas Development Institute, London). The final production process was facilitated by Sam Mendelson (Overseas Development Institute) and Anton Earle (African Water Issues Research Unit), with inputs made by Richard Meissner (African Water Issues Research Unit) and Elvina Quaison (Overseas Development Institute) at earlier stages. The publication would not have seen the light of day without the tireless work put in by Euníce Reyneke, for which the research team is extremely grateful.

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The research process was affected by unstable political conditions in two of the four countries, which reduced the depth and breadth of research undertaken in these countries during the course of the project. However, any errors, omissions and other inconsistencies remain the sole responsibility of the authors.

Introduction

Many regions in the world face a decline in the availability of natural resources as a result of their rapidly growing populations and the associated increased demand for food. This situation is frequently depicted as a 'crisis' scenario, an account beloved by the media and the many global institutions with a stake in the water sector (see ODI 2002). Although a problem undoubtedly exists and the need to identify the factors contributing to 'water stress' is real, it is not necessarily the case that stress will inevitably lead to crisis and eventually to major social conflict or famine, or both. The experiences of a number of countries as far afield as Israel and Jordan in the Middle East and Zimbabwe and South Africa in Southern Africa clearly support this view and show that it is possible for a country to overcome serious water stress. This research project investigates how certain countries have succeeded in overcoming serious water stress and studies the lessons that can be learned from their experiences. It aims to show that an effective system of thought can be constructed from these lessons and experiences, which could then be utilised to inform and instruct decision makers in countries that find themselves entering the 'crunch zone' of serious water stress.

Due to the shared nature of many resources, water problems often require solutions at levels higher than those of states or countries. Water issues have both regional and global significance. Decisions made in one country frequently affect neighbouring countries: more than 260 of the world's major river systems are shared by two or more countries, and these systems account for more than half of the world's total freshwater supply. Upwards of half of the world's population live within these catchment areas. 'Getting it right' in terms of decisions that optimise the use of the resource base – land, water and human resources – is therefore a vital feature of global human development. Embedded within decision-making processes are difficult tradeoffs between national rights, sovereignty over resources, security of economy and questions of social order. These are intrinsically complicated issues that demand decision-making capacities beyond those of the hydrology, agriculture and engineering communities. One of the key challenges is thus to bring the politicians into the decision-making process as early as possible. Without them – and their more informed capacity to choose strategically rational decisions – there will be little room for effective manoeuvre.

The time available for politicians to 'get it right' is increasingly limited. Demands placed upon a diminishing resource base by rapid population growth in certain regions of the world mean that there are ‘pockets’ of urgency. For example, the United Nations’ medium term fertility model currently predicts that the world’s population will reach 9.4 billion by 2050 (half a billion lower than 1994 estimates). According to this model, the world’s population will continue to grow until 2200 when it will stabilise at some 11 billion.

This report first examines the global context, where renewable freshwater supply per person has fallen by 58% since 1950 with the global population growing from 2.5 billion to more than six billion. The urgency, however, lies in specific areas of the world such as Southern Africa where the tools for decision-making are limited and the regional vulnerability of large sections of the population is that much greater. The four countries examined in this report cover the range of ‘categories’ of rich and poor countries, from high to low income. The lessons vary, but the message remains remarkably consistent: the planning of future water development and the identification of options to address water stress demand much broader decision-making capacity than in the past. These also demand greater political commitment to change, sometimes involving some painful political fallouts.

Whereas the political fallout can be highly visible when issues become media-driven, it is more often less visible and longer lasting, involving the retrenchment of positions by communities with large vested interests in the status quo management position. In revealing some of the less visible political credit and debit involved in addressing ‘policy options’, this study hopes to bring a greater level of rationality to the consideration of the water ‘scarcity’ question. Too often the analysis is rooted in simple per capita sums, from which unsustainable assumptions and ideas are extrapolated.

The study is divided into four parts. First, a theoretical and analytical framework is developed, which encompasses recent thinking by both northern and southern social scientists, setting out a broad analytical framework for the remainder of the study. The analysis is necessarily broad in scope to illustrate the key global shifts that have influenced policy in the different countries and that continue to have a profound impact on decision-making at all levels.

Part two examines in detail the regional resource contexts in which the four countries are situated – Israel and Jordan in the Middle East, Zimbabwe and South Africa in Southern Africa – outlining the histories of resource development, periods of social and physical scarcity and the broader policy contexts of changing approaches to resource development. This wider view helps to draw attention to the outcomes of the critical resource issues that are key to national policy-making, of which an important part is the placement of national dilemmas within the context of regional resource stress.

Part three details the national experience of the four countries. Looking at water availability, socioeconomic issues, institutional environments and policy options, this section analyses the resource contexts in relation to wider

development goals, including poverty reduction. This analysis begins the process of narrowing down the output to essential elements of ‘virtual water’, a concept that is central in understanding the output of the study. For greater user-friendliness, this part is divided into two chapters, dealing with the case studies from the Middle East and those from Southern Africa.

Finally, the fourth part applies the analytical framework developed in the first part to the case study material and, from this analysis, develops FoRWaRD, a decision support model that aims to create the conditions for greater decision-making capacity, thus facilitating the identification of future resource constraints and policy options based on the development of scenarios. It is hoped that this decision support model can be tested in appropriate situations in the near future to assess its user-friendliness, the complexity of its data and its capacity to enhance real-time decision-making.

The study encountered two major regional problems affecting research analysis and data collection in the form of the rapidly deteriorating situations in Israel/Palestine and in Zimbabwe. These conflicts prevented the depth of data originally anticipated (particularly in terms of access to key individuals as envisaged in the project proposal), but some measure of substitution was achieved through the use of secondary sources.

Chapter One
Theoretical framework

The global context

This chapter contextualises the research within the international decision-making environment. Global shifts in policy, led by major bilateral and multilateral banks and other emerging networks of professionals, have a direct bearing on the policy environment within which decisions are made. In short, global processes provide key parameters for national and subnational decision-making. For this reason, it is important to examine the ‘crisis’ narratives at work and the responses to them.

Water is not abundant and the proportion of freshwater available globally is miniscule. The status quo will no doubt remain until the cost of desalination makes it economically feasible for the agricultural sector, a development probably decades away. Currently, however, three-quarters of the world’s freshwater is trapped in ice sheets and glaciers. Less than 1% is free flowing on the surface and about 20% is stored underground. In some parts of the world, the distribution of surface flows and groundwater resources is highly uneven and they are often difficult to access. Even countries with a high average water availability can include areas where it is a scarce resource.

Commonly, an annual per capita availability of less than 1,600 m^3 is used to indicate water scarcity or stress. This volume includes both personal requirements as well as the water required to grow an individual’s food. Clearly, the sum will depend on numerous factors, of which one is the person’s diet. A major shift in the type of food consumed can have a huge impact on the volume of water required and its cost. At its most extreme, ‘absolute water scarcity’ is said to exist where annual availability falls below 1,000 m^3. However, the impact of this stress or scarcity – its tangible effects – depends on the nature of the economy in a given area. Principally, this would refer to whether or not food production is in place, nationally or locally, or whether foodstuffs are imported and the ‘embedded’ water used in production has originated elsewhere. This is referred to as ‘virtual water’ and forms a central tenet in this research. It is discussed in more detail in later sections.

Currently, some 30 countries, including South Africa and Zimbabwe, are considered to be water-stressed and 20 others face absolute water scarcity (see figure 1). The latter include Israel and Jordan, which fall well below the absolute scarcity threshold and are theoretically in serious difficulty. The research will show that in both the Middle Eastern countries (Israel and Jordan) and the

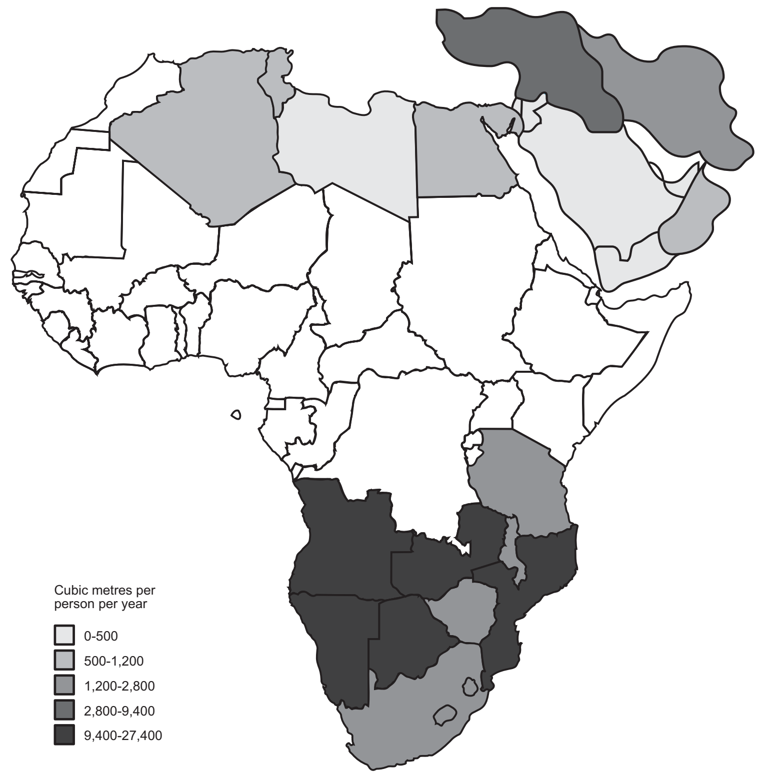
Southern African countries (South Africa and Zimbabwe), important processes exist that can be used to mitigate the stress and to assist societies and economies in overcoming structural challenges. However, in all four case studies specific factors complicate an already difficult situation. Firstly, rainfall variability is an ever present threat for countries in both regions, which demands major restructuring in water usage with its associated sociopolitical impacts. Secondly, the populations of both regions are rapidly increasing with a concomitant increase in the demand for food and an associated demand for water. These countries require the capacity to plan and manage access to the competitive and volatile global and regional food markets.

In future, the competition for food staples will further intensify and global markets are expected to undergo a significant transformation. A report produced for the Second World Water Forum in The Hague (March 2000) by the International Water Management Institute (IWMI) concluded that, by 2025, 33% of the world population, or two billion people (based on UN medium term population growth predictions), will be living in countries or regions with huge water deficits. It is estimated that, by 2025, nearly all countries in the Middle East and North Africa (MENA) will experience absolute water scarcity. This situation will also apply to South Africa, large parts of India and China. These regions and countries will need to supplement their food requirements from other sources. IWMI views the problem in terms of future water needs and predicts that, by 2025, an additional 22% of primary water, mainly for irrigation, will be needed to meet global food requirements. The International Food Policy Research Institute (IFPRI) is even more pessimistic as it foresees a doubling of food imports over the next 20 years. These predictions call for a serious political and economic shift in societies and polities with regard to the contentious issue of food security and national sovereignty. Action will require more than just the improvement of water-use efficiency or the production of 'new' water.

The scenario presented by many experts working in these countries suggests a linear progression to an increasingly difficult situation. However, the progression is far more likely to be a convoluted line littered with peaks and troughs. Many of the deviants from the norm will be caused by a single key variable: global climate change. Major research findings indicate a process of global warming with potentially dramatic impacts on global climate patterns and localised weather systems. The key challenge will be to identify and understand how global shifts will change local rainfall patterns in vulnerable regions.

Over the last three decades, meteorological droughts in Southern Africa and the Middle East have been of major significance, both economically and politically. During the 1980s and 1990s, droughts became potent 'policy vehicles' for major strategic decisions made by communities and governments. Droughts not only force individuals to consider their own vulnerability, but they also drive home the reality of water stress at national level. To date, most models indicate a

FIGURE 1
Freshwater resources per capita in Southern Africa and the Middle East and North Africa (MENA)



propensity towards more frequent 'extreme' weather events. If correct, these events will affect the precipitation levels in areas of global food insecurity. To what degree these areas will be affected is unclear and predictions vary according to the climate model that is used (see Arnell 2000). Deciding what model provides the best strategy is difficult and policy makers are hampered by science when trying to agree on the approach to be employed – stick to the status quo, reallocate water to high value uses, or pursue a low value use strategy. Computer generated scenarios, however, do contribute to the growing scientific knowledge on climate change and provide key additional parameters for decision makers contemplating future strategic options in national water policies.

Although the area of concern in this research is water for food production, it is necessary to include some analysis of the lower consumptive water sectors and place them within the global environment. An inordinate period of time is allocated to the industrial and domestic sectors in the decision-making process in countries in Southern Africa and the Middle East. In addition, there is an increasing convergence between the various sectors and their water requirements. Management issues often overlap especially in terms of water quality and groundwater.

At a global level, some 1.2 billion people lack access to water and 3.3 billion have no effective sanitation, causing or contributing to the deaths of more than three million people each year from water-related diseases. It is estimated that, by 2025, an additional 3.1 billion people worldwide will require access to water and 4.9 billion to sanitation. Of the 3.1 billion who will require access to water, 0.7 billion will live in rural areas and 2.4 billion in urban areas. Of the 4.9 billion who will need access to sanitation, 2 billion will live in rural areas and 2.9 billion in cities. This will present an increasing challenge to policy makers.

Water deficits can have a serious impact on communities. Mortality rates and the loss of productive capacity brought on by endemic diseases have serious knock-on effects on a country's production levels. In addition, chores such as collecting water from distant sources several times a day constrain household decision-making in a wide range of areas. Such time-wasting endeavours often come at the cost of the proper education of children. The impact of this in the long term, both on the household and the wider society, is extremely negative.

Urbanisation is another related issue and one of paramount concern to future resource planners as cities continue to grow more rapidly. The provision of services to peri-urban areas and informal settlements in cities is an increasing social priority. The demands on urban provision often come at a high price to rural areas. In sub-Saharan Africa, 77% of the urban population have access to water services compared to 39% of the population in rural communities. This is compared to the global average of 90% in urban and 62% in rural areas. The disparity between the two areas highlights the links between urban and rural poverty and raises questions of resource allocation. In Zimbabwe, for example, the focus on urban service delivery has significant implications for rural provision, thus contributing to a resource-poor environment. The effect of extensive urban drift has resulted in crucial reductions in agricultural activity and production. The response to the 'crisis' described above centres on three key questions:

- What should be done?
- How should it be done?
- How much will it cost?

In terms of addressing the third question, some experts estimate that an annual funding gap of US $180 billion exists for water provision. This figure is over and above the current expenditure level of approximately US $75 billion per annum and includes the cost of water required for the agricultural sector. Of the

estimated amount, US $30 billion (compared to US $14 billion spent currently each year) is required for water and sanitation. The Global Water Partnership (GWP) believes that 70% of the required funds should come from each country's 'private sector' (including the small-scale sectors). However, it is unfortunately not simply a matter of the division of responsibility. In the first instance, it is difficult to determine who is in fact liable for the funding. For example, the term 'small-scale' private sector is often euphemistically applied to the communities themselves, a sector that may or may not be able to access funds or institutions, and may or may not have the capacity to manage resources effectively.

The increasing focus on private funding reflects general global shifts in development. These were particularly driven during the 1980s by lending conditions imposed by the International Monetary Fund (IMF) and the World Bank and the 'structural adjustments' that economies were expected to make. In general, they reflected the economic ideology of free-market capitalism and the reduced role of the state in public service provision. More recently, however, there has been some scaling back of this ideological commitment to private sector development, not least because the conditions to entry and the development of a nascent private sector are too arduous in many parts of Africa.

In addition to the private sector-driven 'economically efficient' solutions to water problems, there has been a more qualitative focus on the policy options required to increase the efficient management of the resource. The integrated water resource management (IWRM) approach has advocated a cluster of ideas, with the hydrological unit – whether basin, catchment or micro-catchment – as the basic starting point for water resource management. Within this hydrological area, IWRM identifies the range of users as stakeholders, promotes effective governance, encourages cost recovery based on the notion of water as an economic good and sponsors bottom-up planning. The IWRM approach is advocated by many Southern African agencies and networks as it provides a significant parameter for government decision-making on water resource management.

Policy development is not, however, a neutral space inhabited by benign practitioners and users, but rather a hotly contested arena. Within its sphere, conflicting interests collide and new institutional forms sit uneasily with existing practices and processes. This factor is particularly important when considering parameters for effective transition within a state in terms of adaptation to change. It is imperative that the right policy is applied and the appropriate structures are put in place to facilitate implementation. In chapter 5 of this study, a decision support tool is suggested that aims to assist in the development of appropriate policy. The aim is to provide a transparent method for governments to communicate policy to social groups. Two geographic regions that have recently either experienced sudden, dramatic changes or are currently in the process of sensitive political manoeuvring are the Middle East and Southern Africa. The Israeli and Palestinian conflict, apartheid in South Africa and government policies on land reform in Zimbabwe provide examples of situations that can seriously impact the ability of individuals to lead normal lives. Disruptions also constrain and shackle the decision-making environment and sectors such as water often have limited options for addressing management issues.

When investigating water sector development there are also civil liberty approaches that challenge the relevance of perceived wisdoms. For example, emerging civil society groups in many developing countries take umbrage at the neo-capitalist belief that water should be treated first and foremost as an economic good. In their opinion, water issues intersect and crosscut other narratives and address questions of human rights. While they have less influence at present on the political processes of developing economies than on northern development agendas, these budding expressions are nonetheless increasingly being addressed by southern political procedures.

In addition to understanding the context within which change takes place, it is important to know something of the nature of the actual processes of change. Some of these issues are examined below from the perspective of recent thinking by both northern and southern policy practitioners. Questions that are asked include:

- What are the key issues in understanding changes within increasingly resource-poor environments?
- How can these be conceptualised?
- What insights can these issues provide in terms of addressing the policy options facing water-stressed states?

The operation of processes deemed important for mitigating future water stress (including the valuation of 'natural capital' such as water) has proven difficult in many water deficient regions. This reflects the difficulties in determining the cost of resource degradation. In other words, it is hard to establish an appropriate 'precautionary principle'. This principle focuses on economic value and is concerned with either avoiding reduction in stock or preventing reductions in the value of part of the natural capital stock. The precautionary principle has been increasingly applied to water resources. A key way to avoid any reduction and degradation of the resource is to diversify the economy beyond the point where it relies mainly or solely on stock exploitation in order to grow.

The Karshenas model (see figure 2) is an attempt to conceptualise the relationship between economic development and the use of natural capital such as water. This model is readily communicated and helps to explain and predict the nature of the political economy of water in extreme political, economic and water deficient regions, such as the Middle East. Karshenas shows how development has occurred, to some extent, at the expense of natural capital. He recognises that two forms of disaster can arise from the mismanagement of a community's environmental capital:

- ecological – caused by progressive overuse of natural resources; or
- economic – caused by the community's decline into terminal poverty because of inadequate natural resources in the face of new demands (for example, growing populations), or the inability to manage the resources effectively.

The model shows how the development trajectory of an economy can be traced through time (highlighted in figure 3). This is represented in the information space that is delineated by the axes. On the vertical axis, the economic status of an economy is defined through an indicator such as gross domestic product (GDP) per capita, while the status of the economy's natural capital is defined on the horizontal axis. For both axes there are zones of unacceptable and unsustainable circumstances – the zone of unsustainable poverty and that of terminally degraded natural resources. In the Middle East, no economy has entered the zone of unsustainable poverty, although the Palestinian communities have endured unacceptable political economies for decades. In the case of the Gaza Strip, a dangerous depletion of renewable natural resources has taken place over several decades (see figure 4).

The trajectory of Israel is an example of the capacity to respond to environmental and economic challenges, principally through rapid economic diversification and resource capture. Feitelson (1998) describes how the Israeli process was largely facilitated by the decreasing importance of agriculture to the economy. By 1980, it contributed a mere 3% to GDP. Following the droughts of 1990/91, this reduced significance enabled the pricing of water to be used as a demand management instrument. The same challenge applies to the West Bank and Gaza Strip. There is a need to develop substitutes for agriculturally driven approaches that are highly water consumptive. Change, however, is severely restricted by the wider political relationship between the nascent Palestinian state and Israel. Within the current set of circumstances, it is difficult to conceive of development 'alternatives', particularly when urban centres – the key engines of industrial growth – are under such tight shackles. Although on a somewhat different basis, the Southern African situation offers some tentative evidence that a trajectory similar to that of Israel is emerging (Turton 1997; 1998; Jaeger 2001).

Broad modelling of macroeconomic trajectories and natural capital helps countries that are adopting new policy options to prioritise key issues. The capacity to adopt different trajectories is largely dependent upon the 'change capacity' of a country, particularly the capacity to adapt to the fluctuations of a resource over time. In effect, this idea builds on the concept of 'coping strategies'. The idea was previously employed to understand food security and, more recently, it informed the theory of sustainable livelihoods (see figure 5) and the capacity of households to withstand external shocks. The success of its application is based on the ability to access a range of assets, including:

- natural capital, including land and water;
- human capital, including ingenuity;

- financial capital, including the capacity to purchase ‘entitlement’ to other assets;
- physical capital, including the structures of access to resources, markets and other communities of knowledge and commerce; and
- social capital or the range of relations, networks and social regimes that enable and enhance the function of different livelihood strategies.

When extrapolated to national level, the capacity to manage change becomes central to the development of ‘options’ to address water scarcity. Clearly, some capacities (for example, financial capacity) rely on income and using this option may reduce available financial assets in the short term. Managing change can also open up options previously unavailable to policy makers. Instead of using greater volumes of natural capital, water and land to develop agriculture, governments could reallocate water to a more efficient sector and purchase the country’s food requirements on the global market. Important considerations are the sustainability of resource use and policies that result in poverty reduction. These issues are relevant at both the household and national levels.

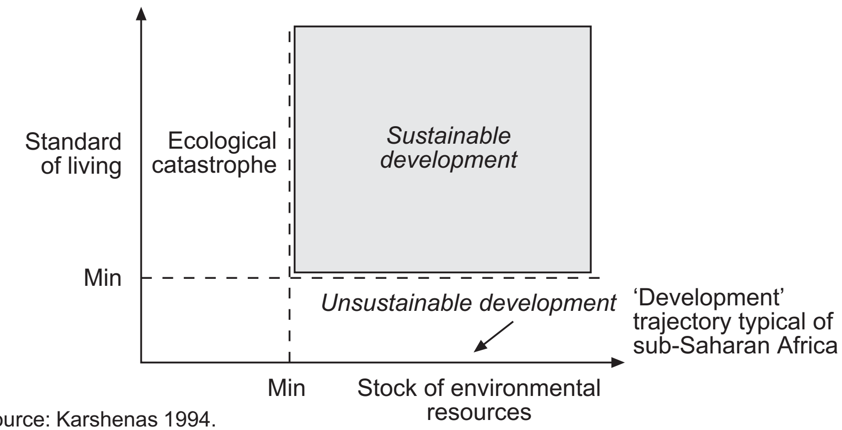
Institutional and policy forums are also necessary to effect capacity change in resource use. The concept of ‘adaptive capacity’ developed by Ohlsson (1999) suggests that the mobilisation of social resources is required in combination with the existing natural capital to ensure adequate resource availability. In effect, this suggested that mobilisation of increased social resources drives the arrows in figures 2, 3 and 4. This is particularly valid in the relatively complex ‘return to a sustainable trajectory’ in the Israeli case study. The stock of social resources, with a capacity to ‘bend’ otherwise unsustainable trajectories, can be called the ‘adaptive capacity’ of a given society. The lack of such a capacity represents what Ohlsson (1999) terms the critical ‘second-order’ scarcity. First-order scarcity refers to the scarcity of the resource itself.

Adapting to natural capital scarcity requires additional inputs of social and human capital until an equilibrium is reached that allows the resource both to be managed sustainably and protected from future ‘capture’. In addition, social and human capital has an impact on the development of policy options for water-stressed countries. Allan and Karshenas (1996) suggest that societies with advanced political economies are able to implement demand management. As suggested above, this involves to a major extent the repositioning of agricultural water within the wider economy to reflect not only the relative importance of agriculture to the economy as a whole (which is frequently in decline – an issue of allocative efficiency), but also to increase the production efficiency of the resource through maximising value added in agriculture.

Understanding the policy change, as well as the human and social capacity to adapt is critical. Policy options that fail to contend with issues of adaptation are likely to fail and create local disputes. This requires that ‘adaptive capacity’ as a solution should be understood within the context of what is politically ‘feasible’,

FIGURE 2

Eco-environmental space: Low environmental capacity and ‘overuse’ of environmental capital



Source: Karshenas 1994.

FIGURE 3

Policies and practices: Common and ‘precautionary’ development trajectories

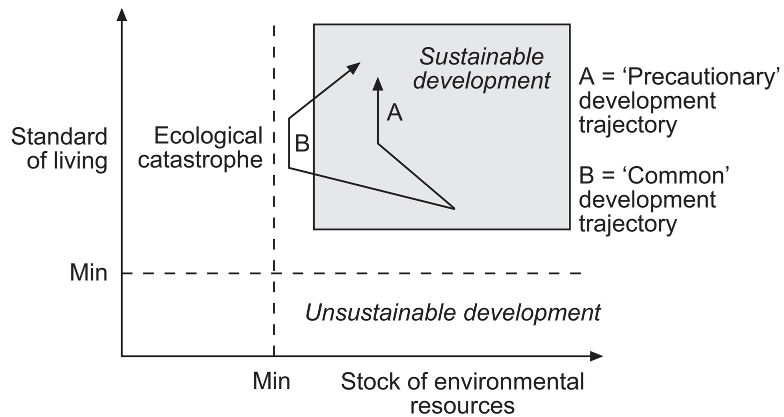


FIGURE 4
Empirical evidence from Israel, the West Bank and the Gaza Strip: Trajectories, 1947-1995

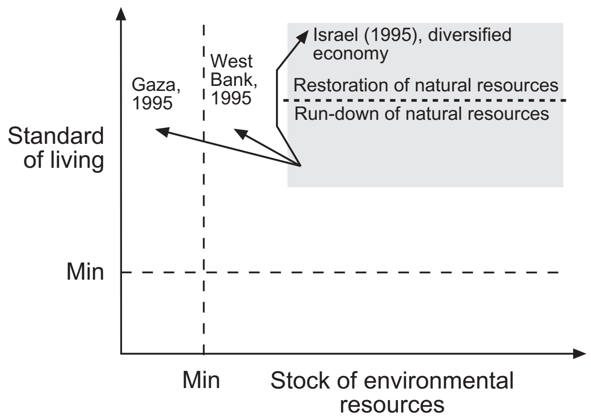
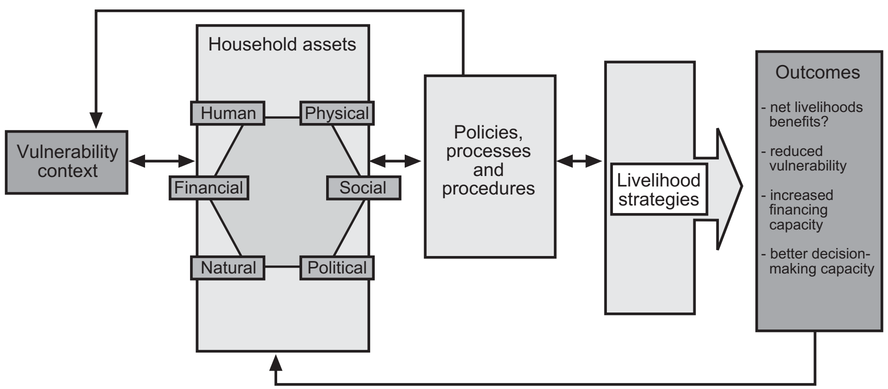


FIGURE 5
Conceptual model of change, adapted from the household sustainable livelihoods framework



Source: Adapted from Carney et al 1999.

rather than politically 'awkward'. Policy makers work at the behest of politicians who want to remain attractive to different political constituencies. In all country case studies, wide variations are evident in the type of political system in operation. However, political leaders pay attention to constituents of interest through various mechanisms. Within governments, political feasibility also exists at the level of institutional capacity, which impacts upon whether institutions are strong enough to address the demands placed upon them.

Part of the problem lies in overcoming the challenges to new policy options presented by civil society. Southern Africa is replete with examples. Heyns (1997) notes that Namibians traditionally viewed rainfall and water supplies as gifts from God. People thus resisted paying tariffs for water when these were introduced. Likewise, the introduction of prepaid water meters in Zwelithle, Hermanus, in South Africa, was viewed with suspicion and meters were frequently smashed, even though the community was disadvantaged as a result (Turton 1999b).

If the capacity to adapt to change in an economy requires a major shift away from water use in agriculture, perhaps to free up water for stressed urban communities (for example, in Jordan and Israel), where will the substitute agricultural production be found? Industrial and domestic needs are almost invariably achievable, rarely accounting for more than 10% of the national water demand. Water for food self-sufficiency is not achievable, however, as this would typically require approximately 90% of the economy's water for agriculture.

One of the key elements of the theoretical framework for this study is the concept of 'virtual water'. Countries that seek access to food staples on world or regional markets, or even from surplus producing areas within the country's borders, are effectively importers of 'virtual water'. This refers to the water that was used to manufacture a given quantity of food during its production cycle. In other words, it refers to the volume of water that was saved through the purchase rather than the local cultivation of the food product. This key concept helps to explain the capacity of economies in regions such as MENA to ameliorate severe water deficits. At least 1,000 m^3 (tonnes) of water are required to cultivate a tonne of wheat. The importation of a tonne of wheat means that the 'saved' volume of water can be reallocated locally. Currently, the importer also wins in the sense that the tonne of wheat is frequently imported at half of its production cost.

Although desalination is fast making the concept of water 'deficits' less relevant (although this mainly applies to countries with a seaboard and those where the key areas of demand are not too far inland), the costs still remain beyond the reach of most countries.

An important theoretical development in the past decade has been the recognition of environmental priorities in the allocation of water. In the political economies of Europe and the United States, environmental and economic priorities were recognised in the 1980s and 1990s, respectively (Allan 2000c). In Southern Africa, environmental priorities were reflected in new national water policy and laws (this is also evident in the two countries reviewed in this study). These environmental priorities increasingly constrain the availability of water for irrigation and further challenge the concept of food self-sufficiency based on water availability. The same is true in the Middle East where, for example, some local pressure groups are addressing agricultural use and water quality deterioration in the Jordan Valley, and challenging the transition of some wetland areas to cultivation.

In regions with temperate and humid climates, most water for agriculture comes from the soil profile. Infiltrating the soil profile after periods of rainfall, water remains for sufficiently long periods to enable seeds to germinate. Enough water is present to facilitate crop maturation for the 100 days or more of the growing season. Invariably, sufficient quantities are harvested for consumption. Only small volumes of freshwater from rivers and groundwater storage are used as supplements. In large areas of Europe and North America, only 10% of freshwater resources are required for supplementary irrigation, representing less than 1% of the total national water budget. The high water availability in combination with highly intensive practices and technological innovation help to provide very high crop yields and production surpluses in some instances.

In both the Middle East and Southern Africa, however, soil water fed by infiltrated rainfall can be less than 5% of the national water budget. Freshwater taken from surface flows and storage and from groundwater aquifers comprise almost 90% of the water budget. When those managing the political economy decide to adopt a food self-sufficiency policy, the competition for water is serious. In the Middle East and Southern Africa, the voices of rural communities – particularly constituencies within these communities that use very high volumes of water for irrigated agriculture – tend to dominate the water policy discourse. The trajectories they favour may neither be the most efficient for national development nor the best for achieving poverty reduction.

The poverty dimension

The above analysis has highlighted some of the key theoretical issues involved in developing ‘policy options’ for water-stressed countries. There is in addition, however, a normative angle to the question, based on poverty reduction as an overarching policy goal. Factors involved in this issue vary considerably between the countries in this study, as the case studies represent a full range of low to high-income countries. Clearly, the issues for a high-income country such as Israel are substantially different from those facing a low-income country like Zimbabwe. Nevertheless, there are complex issues of poverty interwoven within the Israeli experience, issues such as the relationship with the Palestinians, water use, and the economies of the Palestinian territories in relation to that of Israel.

How, why and where the ‘poverty reduction’ goal is placed within the hierarchy of food and water decision-making will impact on the policy options pursued. Nearly

all of Southern Africa is classified as low-income and food deficient, because countries in the region neither produce sufficient food to feed their populations, nor import sufficient quantities to fill the food gap. According to figures of the UN Food and Agriculture Organisation (FAO), some 800 million people remain chronically malnourished worldwide and the gap between production and market demand for cereals is anticipated to increase to 27 million tonnes by 2020.

Achieving food security is obviously a primary consideration for poverty reduction approaches. However, perhaps equally important is the capacity to provide a management regime for water resources that would enable poor communities and households to create both economic and social value from water use. These issues are particularly important because they address one of the key concerns of this study – the ability of governments and societies to adapt effectively to increasing water-stress situations. In theory, therefore, it is necessary to create the conditions at local level (household livelihood security) that will enable poor communities to take advantage of economic alternatives. This could be in the form of moves to greater industrial demand for wage labour, or engaging in small-scale trade and production in their own right. Hence, providing the ‘livelihood’ level of water effectively where it adds value and advantage to the economies of poor households may in fact be more important than ensuring flows to agriculture.

An understanding of the household water economy and its link to the adaptive capacities of households is urgently required. Rural households, rather than the poor, are key components of policy options for water-stressed countries. Much evidence points to the water and livelihood situation of rural households as being a significant constraint to the diversification of activities aimed at reducing vulnerability (for instance in poor rainfall years) and increasing long-term capacity.

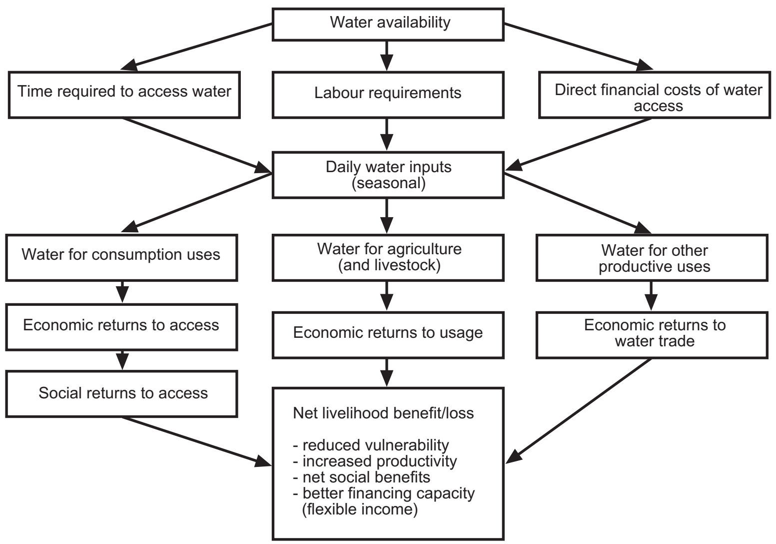
Reaching a comprehensive understanding of the relationship between water and livelihoods at local level is crucial in the development of an effective analytical framework to assess the most appropriate policy options to address water stress. The water and livelihoods assessment builds upon sustainable livelihood approaches. The assessment conceptualises vulnerability in terms of access to and returns on different livelihood *assets* (including natural (water), social and human capital). It assists in highlighting the ways in which policies, institutions and processes enable or constrain different livelihood strategies undertaken by poor households. This approach requires interveners to look systematically at how macrolevel policies and resulting institutions and decision-making processes translate into microlevel livelihood outcomes. The output of such an approach may suggest multiple entry points at both local and national levels for water-related interventions. These would strategically enhance local livelihoods and increase the capacity to adapt to change in future resource availability.

The basic structure of water demand for different livelihood activities can be usefully understood in terms of the *household water economy* (see figure 6).

The need to centralise poverty reduction within the development of policy options requires important regional participation. Increasingly, there is a move towards more integrated approaches to national decision-making on transboundary resources. In Southern Africa, in particular, better coordinated policy on water resources can provide win-win development opportunities for all riparians, with a high potential for poverty reduction impacts. One of the key areas is the management of seasonal river flows on rivers from both the Zimbabwean and South African highlands. Many of these flow into neighbouring Mozambique where large poor communities inhabit lowland river valleys and flood plains.

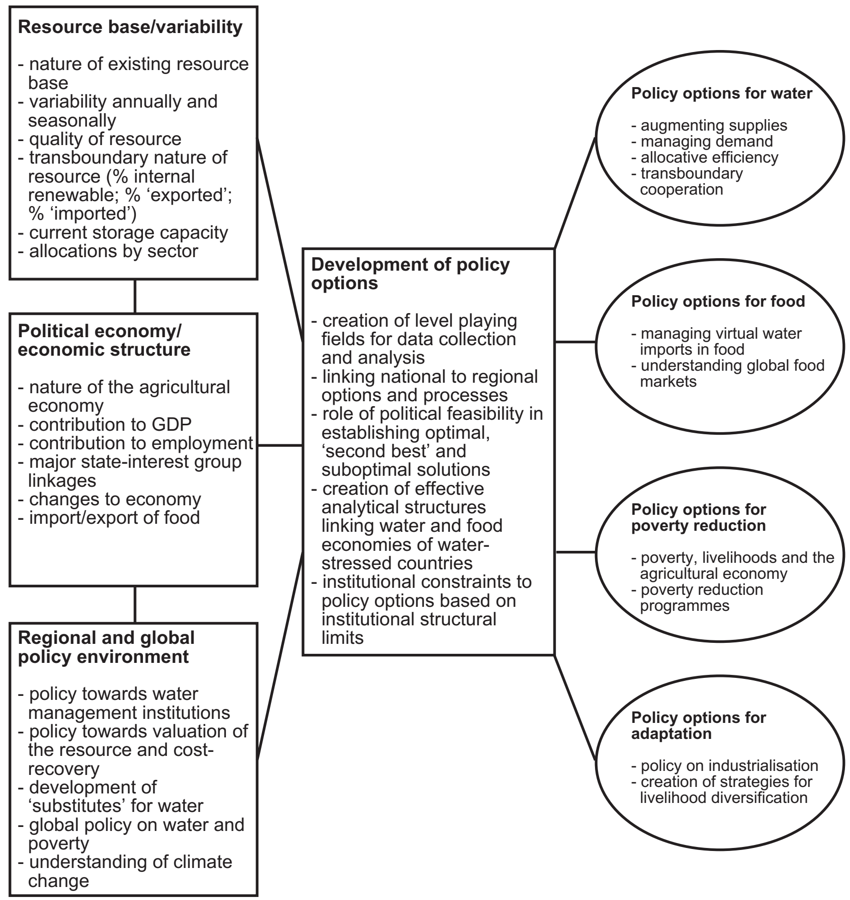
Opportunities for the integration of policy with water and regional poverty initiatives should also address the importance of livelihood diversification as the key to developing effective adaptive capacity. The search for win-win approaches for water-stressed countries will enhance livelihood capacity at a local level. In fact, this may form, in the longer term, an integral part of the process required by countries to adapt and adjust to decreasing water availability.

FIGURE 6
Household water economy



Source: ODI 2002.

FIGURE 7
Analytical framework



Note:
This figure provides an early analytical framework based on the analysis in Chapter 1. It stresses the need for thinking that goes 'beyond the sector', and underscores the complexity of required decision-making processes in socioeconomic, environmental and political spheres. This point is returned to later in the report.

Chapter Two
Regional resource contexts

This chapter provides a context for the four countries under review. In order to understand the circumstances experienced by each country, it is important to consider the wider regional situation. Both environmental aspects and socioeconomic factors are investigated.

The Middle East and North Africa

For the purposes of this study, the Middle East and North African (MENA) region extends from Morocco to Afghanistan and from Turkey to Sudan. By the end of the 20th century, the region had approximately 300 million inhabitants and renewable freshwater resources were estimated at 200,000 Mm^3 per annum (FAO 1997a; 1997b). Given that each individual requires more than 1,000 m^3 of water every year, the region required approximately 50% more water than was available at the time.

MENA countries experience significant population growth and it is anticipated that, by 2025, population figures will exceed 600 million. Water availability in the region varies from the extremely low 220 m^3 per capita in Jordan and 330 m^3 in Palestine to the 2,000 m^3 per capita available to people living in Iran and Turkey (WWC 2001).

Grain imports have steadily increased from the 1970s onwards (FAO 1961-2000). By 2000, imports totalled 50 million tonnes. In terms of embedded water content, this is equivalent to 50,000 Mm^3 water, which nearly equals the volume of freshwater from the Nile allocated to Egypt each year under its 1959 Nile Waters Agreement with Sudan. The region imported 33% of its food requirements in 1995 and more than 38% in 2001 (FAO 2003). This figure is likely to rise to 50% or more by 2025.

Until the end of the 1960s, it was possible for countries to mobilise ‘new water’, although this was increasingly done at the expense of environmental services. From the early 1970s, however, the region’s water needs have become so extensive that they could only be met by over-pumping the groundwater reservoirs and importing water-intensive commodities such as grain. Due to the existence of oil and gas reserves in the region, some countries have developed strong oil-based economies, which made it affordable for them to purchase advantageously priced grain commodities on the world market. This financial security has provided them with the necessary resource base to compensate for the ramifications of water deficiency and has given them an important set of decision-making parameters. At present, MENA is the fastest growing grain import market in the world. Iranian grain imports have recently eclipsed those of Japan, for years the world's leading importer. Currently, Iran and Egypt import more than 40% of the grain consumed by their populations.

A significant issue in the region is the growing urban demand for water. Although the majority of people live in the countryside at present, it is expected that the urban population will exceed the rural population in all MENA countries by 2025. This is likely to have important consequences for patterns of water and food demand.

The four major rivers in MENA are the Euphrates, Tigris, Jordan and Nile. The management of these rivers on a cooperative basis is critical for the future development of riparian states and societies. Irrigation is already an important part of regional agriculture with yields in Egypt at 5.5 tonnes per hectare compared with non-irrigated yields of 1.5 tonnes per hectare elsewhere in the region (WWC 2001). In future, the appropriate development of agriculture, specifically irrigated agriculture, will depend on effective and cooperative multi-state management. States will need to invest in irrigation systems, reform water management bodies and implement innovative agricultural production techniques in order to cope with the increasing demand for food.

There have been some advances in regional interaction and the recent Nile Basin Initiative illustrates the way in which national challenges to water stress can be supported by adding a regional dimension. Multi-state cooperation on the Nile has added strength to national capacities and increased the range of development options. The key concept has been benefit-sharing between states, which is gradually replacing the previous system where each state focused on its own water development strategies. Although there has been no real change in terms of legal entitlements, options for enhancing national benefits have been opened up under the umbrella of regional basin-wide agreements (see box 1).

Southern Africa

At both regional and national levels, water resources in Southern Africa are unevenly distributed. Variability is both temporal and spatial. The arid countries of Southern Africa – South Africa, Namibia, Botswana, Swaziland, Lesotho and Zimbabwe – have a combined population of approximately 60 million. Annual renewable freshwater resources in arid Southern African countries total 140,000 Mm^3. Several countries, for example, Namibia and Botswana, are poorly endowed with perennial rivers and have to rely either on rivers that rise outside their borders, or on internal, unpredictable episodic and ephemeral rivers (Heyns et al 1998; Pallett 1997). In addition to limited resources, countries such as Namibia have problems accessing their water sources (FAO 1995a; 1995b). The more humid parts of Southern Africa include Angola, Zambia, Malawi and

Box 1

The Nile Basin Initiative

The Nile is the world's longest river, flowing almost 6,700 kilometres from its headwaters at the Kagera River in Burundi and Rwanda to its delta on the Mediterranean Sea in Egypt. The Nile Basin Initiative (NBI), launched in February 1999, is a regional partnership comprising the 10 countries of the Nile basin, which share a common goal for the long-term development and management of Nile waters. All 10 countries – Burundi, the Democratic Republic of Congo, Egypt, Eritrea, Ethiopia, Kenya, Rwanda, Sudan, Tanzania and Uganda – envisage sustainable socioeconomic growth through the equitable utilisation of and benefit from Nile basin resources (World Bank 2002). More than 160 million people live within the boundaries of the Nile River basin, while 300 million live in the 10 countries that share the Nile waters. The region is typified by much poverty, instability, environmental degradation and frequent natural disasters. Several of the countries are ranked among the poorest in the world with less than US $250 per capita income per annum. Given the rapid population growth in the region, it is expected that any development within the basin will have important ramifications both on livelihoods and survival strategies.

Although only a transitional agreement until a permanent framework is in place, the NBI has launched a Strategic Action Programme to realise its aims and goals. The programme includes two subsidiary programmes.

Shared Vision Programme – Building a foundation for cooperative action

It is the intention of the Shared Vision Programme (SVP) to create an enabling environment for action on the ground through building trust and developing skills. The SVP currently includes seven projects that build upon one another to form one coordinated programme. Four of the projects are concerned with thematic issues: environmental management, efficient agricultural water use, water resource planning, and management and power trade. Three projects are facilitative in nature: one supports efforts to strengthen confidence-building and stakeholder involvement, another is concerned with socioeconomic development and benefit-sharing, and the final one facilitates applied training.

Subsidiary Action Programme – Seeking mutual benefits and investments on the ground

The Subsidiary Action Programme (SAP) aims to deliver actual development projects to countries involved in partnership schemes. Two SAPs are currently in development. The Nile Equatorial Lakes Region Subsidiary Action Programme

Box 1 (cont.)

(NEL-SAP) includes the six southern basin countries and downstream riparians, Egypt and Sudan. The Eastern Nile Subsidiary Action Programme (EN-SAP) includes three countries: Ethiopia, Sudan and Egypt.

A meeting of the International Consortium for Cooperation on the Nile (ICCON) was held in Geneva, Switzerland from 26 to 28 June 2002. It provided a unique forum for the celebration of the commitment to a long-term partnership by the Nile basin countries and the international community. Apart from state representatives, 40 bilateral agencies, multilateral financial institutions, international organisations and non-governmental organisations attended. At the Consultative Group meeting, more than US $100 million was pledged in grant funds and investment.

The momentum behind the NBI (which is as complex as the development challenges facing it) is opening up new policy space, enabling options to be discussed cooperatively between states in a manner that would have been unthinkable a decade ago.

Mozambique. The total population of these countries is 80 million and water resources are estimated at 630,000 Mm^3 per annum.

Rainfall regimes are dominated to a large extent by the influence of the Indian Ocean. Patterns are mainly seasonal and in many areas most precipitation occurs during a five to seven-month wet season. There is a marked north-south trend in annual rainfall, with an easterly shift from the wet Indian Ocean coastline to the dry west (Falkenmark 1989; Conley 1995). The more humid eastern areas boast 800 mm annual precipitation, with 80% occurring mainly between October and March, while the Namib Desert in the west receives little to no annual rainfall (Calow et al 1996).

In keeping with this rainfall pattern, the river systems of Southern Africa are also heavily seasonal in flow. For this reason, a large number of dams have been constructed on many of the major rivers to store some of the annual flood and to generate hydropower. Given the political history of the region, many of these initiatives are unilateral (or bilateral) and only since the early 1990s, have concerted efforts been made at regional level to address transboundary water management. The level of integration required is clearly evident as two or more countries in Southern Africa share eight main river basins: the Congo, Zambezi, Limpopo, Okavango, Orange, Incomati, Ruvuma and Cunene.

The Zambezi and the Congo (the latter on the northern periphery of the region, but encompassing a significant swathe of Angola's territory) are two of the largest river basin systems on the continent. To give an idea of scale, one hydropower scheme on the Congo alone could provide some 45,000 megawatts of energy, sufficient to meet the entire current demand for electricity in Southern Africa. The Zambezi River is another important regional resource, a fact reflected in the focus on its development by the Southern African Development Community (SADC). It accounts for more than 75% of the region's total mean annual runoff and drains some 40% of the land mass (Chenje & Johnson 1996). Thirty large dams have already been constructed along the river, of which the Kariba Dam (between Zimbabwe and Zambia) at 160,000 Mm^3 is the region's largest. In recent years, the management of these dams has been a point of concern for the downstream riparian Mozambique. Other major rivers with key management structures include:

- the Incomati between South Africa, Swaziland and Mozambique (with 10 dams totalling 12 Mm^3);
- the Limpopo shared by Zimbabwe, Botswana, South Africa and Mozambique (with 43 dams and a storage capacity of 12 Mm^3);
- the Save between Mozambique and Zimbabwe (with 20 dams supplying 2.6 million people); and
- the Orange River between Botswana, Lesotho, Namibia and South Africa, with 29 dams.

To date, transboundary initiatives such as the Zambezi River Action Plan (ZACPLAN), the Permanent Okavango River Basin Water Commission (OKACOM) and the Incomati Basin Initiative have not succeeded in resolving the major issues of allocation and management. It is hoped, however, that these emerging institutional bodies will eventually play an important role in catchment management and will help to pave the way for a more inclusive and bottom-up approach. One of the key issues highlighted by this study is that the policy options of water-stressed states must also include regional dimensions and strategies for water-sharing (Calow et al 1996).

Major Southern African water projects often sit uneasily with the day-to-day requirements of communities. Governments support long-term programmes such as the expansion of irrigation, environmental projects and hydropower development, while many rural and urban households are more concerned with immediate survival. Communities access a variety of local water sources according to the different seasons, but they depend to a large extent on groundwater resources. It is estimated that groundwater provides 60% of the water supply to communities in Southern Africa. This is the result both of relative geographic availability and ease of access through shallow wells and other low-technology structures. In Botswana, an estimated 80% of animals and humans rely on this resource (Chenje & Johnson 1996).

Appropriate groundwater management is hampered by a paucity of data on the resource base combined with a rapid increase in demand due to expanding rural and urban populations. Studies show average aquifer depths range from 30

Box 2

The Southern African hydropolitical complex

Given the high level of dependence on shared transboundary rivers in Southern Africa, the notion of a hydropolitical complex has been put forward. The rationale behind such a complex is that the four most economically developed countries in the Southern African Development Community (SADC) – the Republic of South Africa, Botswana, Namibia and Zimbabwe – are also the most water stressed. This means that water availability can become a factor limiting the future economic growth potential of these countries, and can thus become a driver of either conflict or cooperation. These four countries also share the Orange and the

The Southern African hydropolitical complex

	International river basin								
	Pivotal basins		Impacted basins						
Riparian state	Orange	Limpopo	Okavango	Cunene	Incomati	Maputo	Pungué	Save	Zambezi
Namibia	PS		PS	PS					PS
Botswana	SC	PS	PS						PS
South Africa	PS	PS			PS	PS			
Zimbabwe		PS					PS	PS	PS
Angola			IS	IS					IS
Mozambique		IS			IS	IS	IS	IS	IS
Swaziland					IS	IS			
Lesotho	IS								
Zambia									IS
Malawi									IS
Tanzania									IS

PS = pivotal state IS = impacted state SC = special case

Source: Turton et al 2003.

Box 2 (cont.)

Limpopo, two international river basins, with one another, as well as a series of river basins with other riparian states.

The Southern African hydropolitical complex is based on four key concepts:

- *Pivotal states*: These are the four most economically developed countries in SADC that are reaching the limits of their readily available water resources. This can impact negatively on their future economic growth potential, elevating this to a strategic issue. They are South Africa, Botswana, Namibia and Zimbabwe.
- *Impacted states*: These are the seven riparian states that share transboundary rivers with any one (or combination of) the pivotal state(s). They can be regarded as having felt impact because their water availability has been determined by the needs for and, more importantly, the technical capacity to develop hydraulic infrastructure with which to mobilise scarce water, which their more powerful neighbours have access to. Impacted states thus have limited freedom of choice when using water as a driver of economic growth and development. They are Angola, Mozambique, Swaziland, Lesotho, Zambia, Malawi and Tanzania.
- *Pivotal basins*: The two international river basins shared between the four pivotal states and other impacted states are significant because they have reached a point of closure where no more water can be allocated to economic activities without significant environmental or economic costs. These two basins, the Orange and the Limpopo, are strategically important for pivotal states, but are also important for impacted states.
- *Impacted basins*: The seven international river basins shared by any one of the pivotal states and an impacted state can be regarded as impacted basins. The lack of freedom of choice of impacted states when using water from the impacted basin for their own economic growth and development is significant. The impacted basins are the Okavango, Cunene, Incomati, Maputo, Pungué, Save and Zambezi.

The policy significance of this becomes apparent when the map of perennial rivers in Africa is examined. It shows the spatial distribution of permanent water with large portions of both North and Southern Africa being poorly endowed. The distribution of perennial rivers in the Southern African hydropolitical complex is poor in the four pivotal states, raising the issue of transboundary water to a strategic level.

This conceptual development assists analysts in understanding the strategic interactions between states facing water scarcity constraints to their future economic growth and development prospects. In effect, the different states are locked together in a complex pattern of potential competition or cooperation over

Box 2 (cont.)

a variety of issues, with water resources being just one level of this set of interactions. For this reason, the Southern African hydropolitical complex can be considered as being a component of the 'regional security complex' that Buzan (1991) originally identified.

The distribution of perennial rivers in Africa

Note: The oval indicates the Southern African hydropolitical complex, while the small circles indicate existing disputes over water
Source: Turton et al 2003.

metres in the eastern part of the region to more than 100 metres in the west. However, systems range from the shallow 20-metre aquifers located in the east of Southern Africa to the deep 200-metre aquifers of Botswana and the 600-metre systems located in western Namibia (Fruhling 1996).

When considering groundwater extraction, there are several factors that have to be taken into account. Firstly, most productive aquifers are frequently located in semi-arid or desert subregions, making both the development of the source and the delivery of water to population centres a problem. Secondly, coastal aquifers located near densely populated regions are susceptible to over-consumption and saltwater intrusion that renders the aquifers unusable in the long term. Thirdly, uncontrolled abstraction from deep wells, caused in large part by the rapid development of irrigation, can limit water availability in any nearby shallow wells – often the domain of poorer communities and households.

In some instances, the problem is one of restricted access to rather than the depletion of the resource. Following successive years of poor rainfall, many parts of Southern Africa suffered a 'groundwater drought' in 1992. According to Calow and others (1996), well and borehole failure during droughts occur both as a result of increased demand on low-yielding sources and reduced aquifer recharge. It is suggested, however, that areas susceptible to groundwater drought will exhibit a combination of features that can help in their identification: hydrogeographical zones with low permeability, low yielding boreholes and wells, and areas of high population demand. To date, the emphasis on wells and boreholes has detracted from the focus on the depletion of the groundwater resource base. Government policies and development directives must address the increasing stress on this water supply and take into consideration the various needs of all the stakeholders. In addition, an holistic view of the total water supply is warranted, given the intimate relationship between groundwater and surface water.

Drought is another issue that urgently requires government scrutiny and action. In Southern Africa, droughts are significant not simply in terms of their effect on economic and social structures, but also as events that can influence policy makers. In addition to predictions of impending droughts and floods, policy makers desperately need information on long-term climatic shifts. The problem is the degree (or lack) of certainty about current knowledge. Predicting rainfall change solely on the basis of rising temperatures is problematic for regions such as Southern Africa as account needs to be taken of those events and atmospheric processes that affect 'extreme' weather, such as the El Nino Southern Oscillation (ENSO). Only the broadest shifts are currently identified by climate change experts. These suggest that, by the 2080s, there will be an increase in rainfall in the equatorial areas of Africa and decreases in precipitation levels during the Southern African summer rainfall season. Although these predictions relate to the far future, there is an urgent need to begin implementing mitigation strategies. This is especially pressing when considering the anticipated increase in population in the region and the associated higher demand for resources.

In South Africa, in particular, the last major drought occurred just prior to the democratisation process and 'policy space' was opened up that enabled a radical reconsideration of water management priorities (Turton 1999a). In Zimbabwe, the drought experience has exposed the vulnerability of the national economy in times of stress and highlighted the fact that individual households can be mobilised to help mitigate the impact of these events. For example, in 1992, 40% of Zimbabwe's population was affected by drought and the gross national product (GNP) fell by an estimated 12% (Benson & Clay 1998). The slaughter and sale of 600,000 head of cattle provided temporary local employment and compensated for the acute decrease in annual household maize production, from an average three tonnes per household in 1991 to less than half a tonne in 1992. The slaughter and consumption of livestock offered an important coping mechanism for rural Zimbabweans at a time when the response from the government and agencies was inadequate (Waterkeyn in Nicol 1998). In terms of access to water, households played a key role in maintaining individual water points during the drought. In particular, upgraded family wells continued to provide water supplies in many areas. During this time, only 10% of household wells failed compared to the 40% unproductive government-run wells. The well-deepening initiative taken by family members as the water table sank, combined with careful rationing of water use (which included giving up vegetable plots), allowed many communities to access sufficient volumes of water to survive (Benson & Clay 1998).

As a whole, Southern Africa is not heavily dependent on imported food, with only 17% of its grain imported from outside the region in 2001 (FAO 2003). However, there is a high degree of temporal and geographic variation. Dry countries, such as Namibia and Botswana import close to 80% of their grain requirements, mainly from South Africa. During the drought of 1992, the region had to import close to 50% of its grain, due to the high reliance on rainfed agriculture. Many of the more humid countries also rely on grain imports, but this frequently has less to do with climatic factors and more to do with structural factors. For example, the northern region of Mozambique recorded a 100,000 tonne grain surplus in the 2001/2002 growing season and was able to export some of this to Kenya (FAO 2002). Yet, the country had to rely on imported grain for its dry southern sections, reflecting the high internal transport costs in countries like Mozambique.

Chapter Three
The resource environment in selected Middle Eastern countries

This chapter investigates the water regimes of Jordan and Israel/Palestine and illustrates the particular conditions and related constraints affecting their freshwater environments. The discussion of the country case studies is divided into four sections. The first is concerned with the natural conditions and overall water availability. The second looks at socioeconomic activities driving the demand on resources, with particular focus on factors such as population growth, economic expansion and basic rights. In the third section, institutional structures and bodies are investigated as the countries have all undergone some form of government restructuring with implications for water resource use. The final section addresses policy on national water resources and the way in which freshwater resources are managed by the various authorities and government officials.

Jordan

Water availability

Jordan's lack of water is a fundamental feature of economic, political and social factors. Most of Jordan is situated on an arid plateau, which receives little or no rainfall. Only 25% of the total area of Jordan is sufficiently humid for cultivation, making dependence on irrigation inevitable. Rainfall varies between 630 mm in the hills overlooking the Jordan Valley to as little as 200 mm elsewhere on the plateau. Most urban Jordanians experience problems of water supply first-hand, with water supplied through the system only once a week in the summer months.

Jordan is currently one of the most water-scarce countries in the world. According to official figures, available water resources were estimated at 960 Mm^3 per annum at the end of 1999, leaving an annual water deficit of some 220 Mm^3. Effective strategies are urgently required to address this situation.

Demands on the country's scarce resources are great, particularly from agriculture, which receives some 68% of all allocated water. The remaining water resources are allocated to the domestic sector (27%) and industry (5%). Jordan is rapidly exploiting much of its groundwater resources, situated mainly in the eastern desert. In the mid-1990s, these sources provided some 60% of the total supply. Some of these reserves are fossil aquifers and currently these sources are estimated to have a safe yield of some 275 Mm^3/year. At present, 2,449 government and private wells access the important groundwater resources. The

Box 3
Jordan River basin

Approximately 13.3 million people live in the Jordan River basin, which covers an area of 42,800 km^2 and is shared by Jordan, Israel, the West Bank, Syria, Egypt and Lebanon. Although the length and flow capacity of the Jordan River are relatively modest when compared to other rivers in the Middle East, the basin system is the largest surface water resource in the area. The region is beset with a variety of challenges: political fragility due to conflict between countries, limited water resources (with the exception of Syria) and ever increasing population growth rates. Water is often regarded as a political tool in the region and has led to countries pursuing unilateral water policies and domestic resource management plans. The lack of a comprehensive water-sharing strategy has not only led to a worsening of the overall water situation in the basin, but has also adversely impacted on wider regional development.

Joint regional management of water resources and sound water agreements are urgently required. Although water has been perceived as a divisive issue, which can undermine prospects for development, it also possesses an incentive for regional cooperation and can be viewed as an important instrument for peace among the riparian states. The research for this project included two countries in the Jordan basin: Jordan and Israel (including those Palestinian areas occupied by Israel). These countries have no other significant surface water sources and only limited groundwater reserves. Jordan receives half of its water requirements from the basin, while Israel utilises the surface resource for 40% of its domestic water consumption.

regulation of abstraction and enforcement of licensing pose major challenges for the government.

Whereas agriculture consumes more than two-thirds of the country's available water, it contributes less than 10% of GDP and is shrinking further in importance (see figures 8 and 9). Currently, the bulk of agricultural activity takes place in the Jordan Valley. The only rainfed agriculture possible is undertaken in the upland catchment of the Jordan River (accounting for some 90% of the cultivated area). Of the 36,000 hectares of irrigated land in the Jordan Valley, approximately 28,000 hectares are currently under cultivation. The remaining 8,000 hectares lack sufficient water for development. Another factor with an impact on cultivation is the high cost of irrigation, at US $3,000 per hectare. Additionally, each hectare requires 1.5 labourers, making cultivation in these areas economically unattractive.

Droughts in the 1980s and 1990s increased perceptions of Jordan's acute vulnerability both among government agencies and the wider society. The response included both supply and demand-oriented strategies. The former is in some ways a response that is less domestically awkward, although more internationally contentious, particularly where this involves joint ventures with neighbouring states. To date, construction activities have included raising the height of the King Talal Dam. Its reservoir capacity has been increased to 90 Mm^3 and has provided supplementary irrigation flows to the East Ghor Canal at Adasiyah. Other projects include the Maqarin or al-Wahda (unity) Dam and an associated hydropower station on the Yarmouk River in a joint venture with Syria. This is expected to provide additional storage of 225 Mm^3, although its apportioning remains a contentious issue. During the 1990s, there were also plans to increase storage capacity through raising the height of the Kafrein Dam, thus increasing reservoir capacity from 4.3 to 7.5 Mm^3. By the mid-1990s, new dams were constructed at Walah, Karameh, Mjib and Tanur, creating a combined additional storage capacity of 115 Mm^3.

On the demand side, considerable emphasis has been placed on reforming irrigation in the Jordan Valley. Schemes have included the transfer of technology to enable increased drip methods and other forms of irrigation that consume less water. The government aims to save up to 20% in some areas. The importance of reforming water use in the agricultural sector is evident as farmers currently use some two-thirds of the country's total water supply. A 20% reduction in flows to agriculture could reduce demand on water by this sector by some 210 Mm^3. This is roughly equivalent to the total current annual water deficit. One of the key challenges faced by policy makers and implementers is the shifting of preferences for cropping highly consumptive citrus varieties and bananas to less water intensive species. These crops are of high value to individual farmers, but their cultivation places a high opportunity cost on the rest of the economy. Other sectors, including agriculturalists farming lower valued produce, are forced to compensate for their water requirements through additional capture, production and exploitation.

The highly contested Jordan River remains the focus for agricultural efforts and other water expansion programmes. Most of the agricultural development budget is currently spent on its development. The river is fed by tributaries and springs along its length and flows roughly due north-south before finally discharging into the Dead Sea. Annual average discharge, including that of the Yarmouk River that feeds into the river south of the Sea of Galilee, is around 1,300 to 1,500 Mm^3. The first 96 kilometres of the Jordan River flow through Israel and the remaining 152 kilometres through Jordan. Key management challenges on the watercourse are capturing excess flows in years of high rainfall and regulating discharge effectively. Although the Sea of Galilee receives between 800 to 910 Mm^3 of flow each year (of which about 600 Mm^3 comes from the Jordan and its tributaries), this is reduced after evaporation to only 610 Mm^3. Its low operating capacity means that the sea cannot act as a useful international reservoir even if it was politically feasible to do so.

South of the Sea of Galilee, the flow of the Jordan River is substantially reduced by the Israeli National Water Carrier offtake. Irrigation in and around the sea itself further reduces capacity. The southern drainage basin of the Jordan-Yarmouk (mainly in Jordan itself) supplies about 749 Mm^3 of water.

Socioeconomic issues

Given the highly charged political context of the region and the protracted political crisis in neighbouring Iraq, the socioeconomic challenges facing Jordan go far beyond the issue of water and agriculture. Jordan is home to tens of thousands of Palestinian refugees and the Israel-Palestine conflict has had a permanent effect on the country's economy and society. One of its biggest impacts was the annexation by Israel of the West Bank of Jordan in 1967.

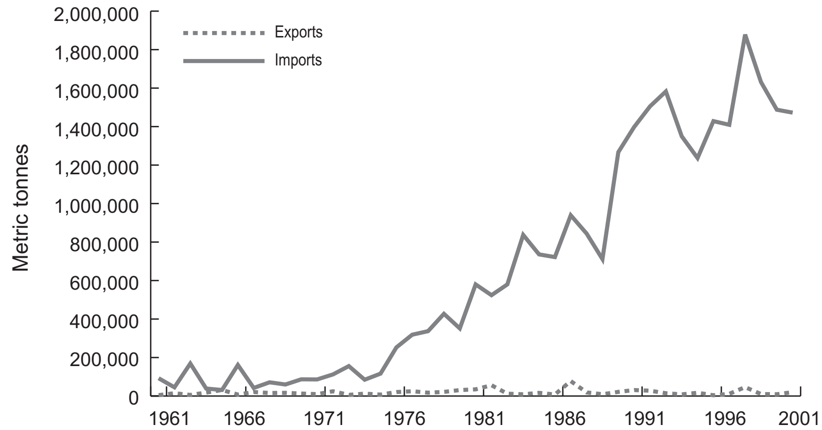
In addition to the precarious political climate in the region, there is also substantial meteorological variability. Years with poor rainfall figures can add further strain to the country's limited water assets. For example, between 1987 and 1990 flow in the Jordan River dropped by about 50% and levels in the Sea of Galilee, the key upstream source, reached an all-time low. Late in 2000, the Sea of Galilee was said to have reached a level 80 metres below the lowest point ever recorded. The lower the lake gets the greater the cost of pumping water up into the National Water Carrier. In 2001, however, the Jordan Basin countries experienced a significant rainfall event that allowed the region's major aquifers to reach higher levels than those experienced in 1967.

Jordan's population at the end of the 1990s (East Bank only) reached 4.8 million with densities at 56.4 people/km^2. Some 20% of this total lived in the capital Amman. The population of the Jordan Valley itself rose from 63,500 people in 1973 to approximately 280,000 in 2000. Even when taking this increase in population into account, the proportion of employment provided by agriculture has declined during this period. According to the Ministry of Labour, agriculture provided only 7.3% of employment compared to 48.7% provided by the service sector in 1992 (the last year for which official figures were available, reflecting Palestinian citizens only). The rise in agricultural imports and the highly fluctuating nature of agricultural production is evident in figures 8 and 9. This helps to underscore the precarious nature of the sector in a resource-poor environment and the unremitting increase in demand for food imports as the population grows.

Institutional environment

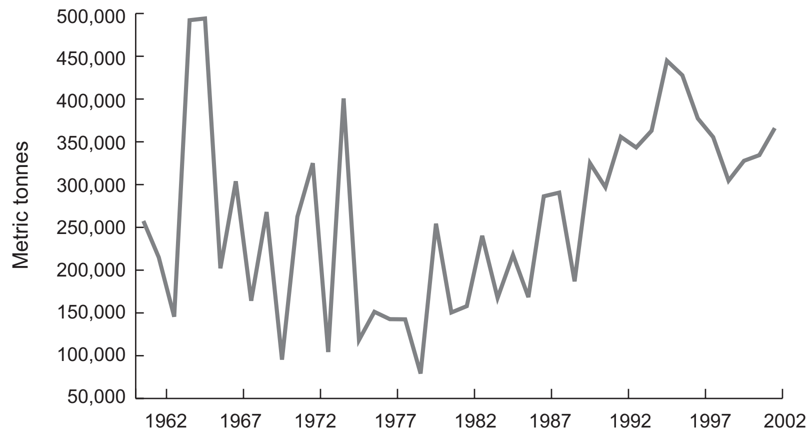
The institutional environment is dominated by issues of transboundary resource management between co-riparians and the area has witnessed a number of attempts at effecting transboundary management institutions over the years.

FIGURE 8
Total agricultural trade for Jordan, 1961-2001



Source: FAO 2003b.

FIGURE 9
Total agricultural production for Jordan, 1961-2002



Source: FAO 2003b.

This section therefore applies to all Jordan basin riparians (see the following section on Israel and Palestine).

Management efforts preceded the creation of the state of Israel in 1948, but received renewed impetus as US foreign policy focused firmly on the region during the 1950s. The cause was championed by the then US Ambassador Johnston, who led the attempts to reach a comprehensive transboundary agreement termed the Johnston Plan. It was, however, never fully implemented, although it is claimed that the plan, in fact, formed the basis for the Jordan-Israel water-sharing agreement.

The 1956 second version of the Johnston Plan envisaged equitable water allocations for all co-riparian states based on separate national level development of water resources. Of the total estimated annual water availability of 1,287 Mm^3, Syria was to receive 10.3% (132 Mm^3), Jordan 56% (720 Mm^3), Israel 31% (400 Mm^3) and Lebanon 2.7% (35 Mm^3). This plan includes many features either currently incorporated in the Israeli-Jordan Peace Agreement, or under consideration for future inclusion. At the time, the political concerns of several riparians prevented final acceptance of the plan even though states had been close to signing it at one point. The failure to reach a comprehensive approach to the river's development allowed the establishment of unilateral programmes during the 1950s and 1960s. This approach, in effect, set the benchmark for future development of the river. Following Israel's military victory in the Six Day War in June 1967 and its subsequent occupation of the West Bank of Transjordan and of the Golan Heights in Syria (including, critically, the remaining half of the Sea of Galilee), Israel extended its dominance over the region's water resources.

Not until the Oslo Peace Process between Israel and the Palestinians in the early 1990s did political relations warm sufficiently to enable further joint decision-making on the river. Cooperation received a boost in 1994 when Israel and Jordan signed a peace treaty (Shapland 1997). Pursuant to clause 6 (and annex II) of the treaty, there is recognition of the rights of both sides to the waters of the river, agreement on the principle of no harm and recognition that water sources for both sides are inadequate for their needs. Practical issues included water-sharing, the timing of allocations and water quality issues. Under the treaty's provisions, Israel agreed to provide Jordan with de facto storage services for 20 Mm^3 and both parties agreed to desalinate saline water diverted from the Sea of Galilee (although this body of water was deliberately not mentioned by name), of which Jordan was to receive 50%.

Nevertheless, problems with the agreement remained. Inevitably, considering its bilateral nature, these included the failure to address Lebanese, Palestinian and Syrian claims. It also neglected to make provision for years of low rainfall levels thus preventing either party from pursuing drastic unilateral action to ensure supply availability. A joint water committee was established for day-to-day management issues, including the implementation of current arrangements and

the discussion and planning of future activities. Efficient functioning of the committee has been affected by wider Arab-Israeli hostilities and by practical issues such as data-sharing.

Several key initiatives under the auspices of 'peace projects' have directly resulted from the treaty between Israel and Jordan. These projects include the regulation of the Yarmouk River, the development of a desalination conveyor to urban Jordan, storage facilities on the Jordan River and in several side wadis, and the Addasiyah Diversion Weir Project. The total estimated cost for these developments is in the region of US $582 million. Many of these projects are related to earlier proposals made under the Johnston Plan.

Jordan has also initiated bilateral projects with Syria. One of the most important of these projects is the construction of the al-Wahda Dam (earlier proposed under the Johnston Plan as the Maqarin Dam). Following the signing of an agreement in 1987, progress has advanced significantly, despite problems between the two countries after the outbreak of the Gulf War in 1991. The dam's significance for Jordan is its ability to capture and regulate seasonal flows of the Yarmouk River. The total construction cost of the project was US $150 million and the anticipated yield to Jordan is expected to be between 80 and 150 Mm^3 per annum.

Current and future cooperation on water resources is more problematic. The increasingly conflictual political environment has the potential to jeopardise future agreements on major water-sharing issues. Projects such as the Al-Addasiyah Diversion Weir are now unlikely to be undertaken. The project would divert some 20 Mm^3 of incremental water into the King Abdallah Canal with a total capital of US $30 million and recurrent costs of US $300,000 (1996 prices quoted). Progress on a US $150 million joint desalination plant for brackish spring water between Israel and Jordan has also been frozen due to financing and siting issues (whoever hosts the plant has to deal with its substantial environmental implications). The plant was expected to provide 50 Mm^3 of drinking water to Jordan.

Various donor agencies, however, remain involved in major projects in the Jordan basin. USAID, a key donor in the area, focuses on enhancing water sector institutions, increasing efficiency in the use of water resources and improving the quality of wastewater. It has helped to introduce a new financial accounting system for the Jordan Valley Authority. Public education programmes on water issues have been created and skills enhancement courses for technical staff are provided. USAID also liaises with other donors in the region. One such a multi-donor collaborative effort involves the restructuring and rehabilitation of 18 zones in the Amman water system. Although outwardly supportive of the projects and programmes under way in the basin, donors privately question the regional and national capacity of the countries concerned (these questions are echoed in Southern Africa, as the next chapter shows).

In terms of regional capacity, one of the most obvious concerns is the political pressures at play in the region. Volatile relations between the riparians are longstanding and it is difficult to foresee any change in the status quo in the short term. The structures of governments vary considerably in the Jordan basin, as do the economies and societies. Such diversity is not specific to this region, but when combined with the lack of political will, it impacts on regional innovation and progress. Donors perceive these factors as impediments to successful advancements. They are especially concerned that the individualistic nature of many of the governments hinder the ability to allocate donations and funds wisely and in the best interests of all parties.

Due to the spillover effect, transboundary issues and regional capability also reflect, in part, national capacity. Given the links between farming interests in the Jordan Valley and the political elite in government, conflicts within national institutions in terms of the management of state water are not uncommon. In Jordan, the political system ensures strong control by powerful civil society groups such as the Jordan Valley farmers. Similar political influence extends to the control of the abstraction of water from aquifers and crop selection. These groups enjoy unregulated use of surface and groundwater, an acute problem in Jordan despite laws regulating abstraction and the cultivation of crops with high rates of water consumption. Although small in number, these civil organisations enjoy significant influence as a lobby group. Many in the Jordanian water industry are concerned about the impact of this situation on the long-term national water resource.

Policy options

Jordan faces acute water stress problems in coming years. The only realistic solution is to transfer water away from agriculture to ease pressure on domestic and industrial users. While desalination is regarded as a possible solution, it does have a number of limitations – for example, Jordan has an extremely short coastline to which the residual saline solution can be disposed.

Supply augmentation programmes may also not be sufficient to eliminate the projected deficits. Developments such as the al-Wahda Dam are expected to supply lower yields than originally anticipated. New figures for the project are 80 Mm^3 water for Jordan and 10 Mm^3 allocation to Syria. An additional, unexpected problem is protecting the quality of return flows from Syrian irrigation in the upper Yarmouk region (an application not originally part of the agreement between the two countries).

The critical issues across much of the country are maintaining water quality and managing wastewater use. To this end, future foreign donor input into the national water sector will focus on wastewater treatment and management. The Jordanian government has also shown its willingness to increase water efficiency by making improvements to national water bodies. The Water Authority of Jordan (responsible for groundwater) recently signed an agreement with the Jordan Valley Authority. The main aim of the partnership is to increase water management capacity within the country. Effective policy development at national level is impeded, however, by the lack of key professional expertise in the areas of policy and decision-making. The country is undergoing a brain drain both at national level, from the public to the private sector, and internationally with educated and trained water professionals often enticed by large salaries and perks elsewhere in the Gulf.

This loss of skilled capacity comes at a critical time for Jordan. Nationally, the water deficit has risen from 501 Mm^3 in 1995 to 559 Mm^3 in 2000. Government figures predict an anticipated deficit of 620 Mm^3 by 2010. Remedies to alleviate the situation have been set out in Jordan's Water Development Strategy to 2011, published in 1997. The strategy itemises 61 projects with a projected cost of US $5 billion. Major projects included in the strategy are, among others, the Three Dams Project that will provide water for Dead Sea industrial and tourism projects, and additional water for extending irrigation in the southern Jordan Valley. A second major project is the construction of a 325 kilometre conduit that will allow 110 Mm^3 water to be brought from the Disi (fossil) aquifer in southern Jordan to Amman. In concert with this supply augmentation, additional improvements to Amman's water supply (a city accounting for some 35% of the country's total water demand) are to be sought through the Greater Amman Water and Wastewater Project. Current losses to Amman's water supply are estimated to be as high as 50%. Figures for other urban areas are even higher, with loses indicated at 80%. Overall, the projects are expected to raise water consumption from the 1,451 Mm^3 required in 1995 to 1,720 Mm^3 anticipated for 2010, of which 1,088 Mm^3 (63%) will be used in agriculture.

This hefty allocation of water to agriculture is one of the fundamental problems facing water-scarce Jordan as the sector contributes a mere 5 to 6% of GDP. Some donors, including USAID, have tried to encourage the raising of tariffs on water through conditionality, but there has been widespread resistance to this. Various media have been employed to increase awareness among the general public to the acute water scarcity. Future external support will also most likely depend on increased tariffs. The current average price is some US $0.02/m^3 but this would need to be raised significantly in order to reflect the real cost of agricultural water.

Policy options are also being pursued at local level to address current water limitations. Farmer irrigation efficiency is one area that is currently targeted. Problems exist particularly at the tertiary level where there is competition and allegations of water theft between farmers. Efforts are being made to establish small-scale water manager associations, with each group consisting of 10 farmers. The aim is to facilitate better relationships between farmers and government aid programmes and interventions. Training will be provided on alternative irrigation techniques and advice on sensible crop selection will be given.

Israel and Palestine

Water availability

In common with Jordan, Israel and Palestine (comprising the Occupied Territories of the West Bank and Gaza Strip) are severely water-stressed. For decades, water consumption has been in excess of natural water production capabilities. By 2000, the per capita resource potential for both Israel and Palestine was estimated at 250 m^3 and 115 m^3, respectively, placing these countries at the bottom end of the world water poverty scale.

The headwater of the Jordan River originates from three tributaries, the Dan, Baniyas and Hasbani. These three waterways merge in Israel north of the Sea of Galilee to form the upper Jordan River. Of these tributaries, only the sources of the Dan originate within Israel. Both the Hasbani and Baniyas are located in areas that have been, or are currently sites of political contention. The Hasbani springs are located in the southern part of Lebanon, an area situated within the Israeli security zone until June 2000. The Baniyas waters drain from the Golan Heights, a territory occupied by Israel since the 1967 war with Syria. South of the Sea of Galilee, the Jordan joins the Yarmouk River where it continues to flow in a south-westerly direction to the West Bank. However, on reaching Palestinian territory, the river is usually no more than a brackish muddy stream, due to intense extraction by the upstream riparians – Israel, Jordan and Syria.

Groundwater, also supported by the Jordan River basin, is the principal water resource in the region. Israel and Palestine share two aquifer systems: the mountain aquifer (located under the hills of the West Bank) and the coastal aquifer (positioned under the coastal zone, including an area covered by the Gaza Strip). One of the greatest challenges facing Israel has been the transfer of water from the relatively wet north of the country to the southern cities and agricultural areas. To this end, a key feature of the country's management system was the development of the National Water Carrier in the 1960s, providing an annual capacity of 320 Mm^3. Constructed amid considerable controversy and tension with neighbouring countries, this structure helps to supply the Negev Desert area. Currently, it provides water at a cost of approximately US $0.25/$m^3$ (about half the cost of desalinated water). The price paid by farmers, however, amounts to US $0.15-0.20/$m^3$ – their water is substantially subsidised.

In the Gaza Strip, limited surface water places a huge demand on available groundwater. Because groundwater is severely overpumped, the groundwater table has lowered below sea level and, in many areas of the aquifer, sea water intrusion and high salinity levels have resulted (Sabbah & Isaac 1995). The rapidly declining quality of Gaza's groundwater is a source of international concern. Irrigation of the important citrus crops in the Gaza Strip is seriously affected by raising salinity. The salinity of some groundwater is three times higher than the World Health Organisation's (WHO) recommended safe levels. Palestinians have no direct access to the Jordan River under Israeli occupation.

Rainfall figures for the West Bank are also variable. In the relatively high altitude region, the range is between 600 and 800 mm per annum, but levels fall to 200 mm in the eastern part of the Jordan Valley. In 1998/99, the Palestinian economy was severely affected by drought.

At present, many working in the Israeli water sector are concerned about the deteriorating quality of resources due to agricultural, industrial and demographic pressures. Intensive agricultural techniques combined with persisting water scarcity have resulted in degradation of the water quality in much of Israel. The coastal aquifer, situated beneath almost one-third of the Israeli population, provides water for many industrial and agricultural endeavours. Recent studies have found high levels of contaminants in the groundwater, including nitrates, fuels, heavy metals, chemical pollutants and toxic organic compounds.

In Israel, agriculture as a consumer of water has been rapidly declining, in part reflecting government policy to stem usage, but also resulting from the declining value of agriculture to the Israeli economy. Water consumption in Israel in 1999 reached 2,151 Mm^3 of which 59% was used by agriculture, 32% by domestic users and 6% by industry. In the mid-1980s, 70% of available water resources were allocated to agriculture (Deconinck 2002).

The development of non-conventional water resources has been a priority for Israel and efforts have focused on various options, including reclaimed wastewater effluents, intercepted runoff and desalination. In 1999, it was estimated that 300 Mm^3 (25%) of the total volume of water supplied to irrigation was in the form of reclaimed sewage effluents, a figure expected to increase to 600 Mm^3 by 2020.

Several local and regional intercepted runoff schemes exist, which divert stormflow from rivers into reservoirs. Currently, 40 Mm^3 are intercepted and either pumped into the supply system, or allowed to percolate into the underground aquifers. Experts estimate that a further 95 Mm^3 water can be generated from stormwater over the next few years.

A further key development has been the progress of proposals to develop desalination capacity. Although the grandiose Red Sea-Dead Sea Canal Project – projected to provide 850 Mm^3 of water per annum at a cost of US $4.5 billion – has yet to be taken forward, other smaller desalination plans are currently under construction. In the long term, desalination is seen as the most economically

TABLE 1
Total Israeli water availability and consumption over four decades

Israel	1999	1998	1997	1996	1995	1990	1979/80	1969/70	1964/65
Total water (Mm^3)	2,151	2,226	2,074	2,041	2,029	1,939	1,743	1,711	1,393
- Of which Kinneret	*94*	*376*	*386*	*386*	*371*	*153*	*273*	—	—
- Wells	*1,336*	*1,100*	*976*	*955*	*982*	*1,126*	—	—	—
Total consumption (Mm^3)	2,073	2,166	2,008	2,013	1,983	1,804	1,700	1,564	1,329
- Of which agricultural	*1,264*	*1,365*	*1,264*	*1,285*	*1,275*	*1,216*	*1,235*	*1,249*	*1,075*
- Industrial	*127*	*129*	*123*	*124*	*120*	*106*	*90*	*75*	*55*
- Domestic	*682*	*672*	*621*	*604*	*588*	*482*	*375*	*240*	*199*

Source: Government of Israel 2001.

viable guarantee of Israel's water security. Costs have fallen almost tenfold since the late 1970s to about US $0.50/m^3 at current prices.

Socioeconomic issues (Palestine)

In mid-2000, the population of the Occupied Territories was 3.2 million with an extremely high average density recorded at 535 persons/km^2. Roughly two-thirds of the population live in the West Bank and a third in the Gaza Strip. However, the population pressure in the Gaza Strip is extremely severe as the territory occupies a mere 6% of the total land area.

The Palestinian economy was formerly tied to Israel's market through employment. Israeli construction, in particular, relied to a great extent on Palestinian casual labour. During the early 1990s, 35% of the population in the West Bank and 45% of Gaza's workforce were employed in Israel. Since the Al-Aqsa Intifada in 2000, this economic relationship has been suspended.

Palestinian refugees, Jerusalem, Jewish settlements, the status of a future Palestinian entity and water are the most important factors constraining attempts to establish peace between the Israelis and Palestinians (Deconinck 2002). Israeli domestic water policy has a serious effect on populations living in the riparian states and especially on those living in the Occupied Territories. The major issues of poverty and water use relate to the occupation of Palestinian lands since 1967

and arise from both common problems of agricultural demand, as well as the severe restrictions placed on available water by illegal Israeli settler communities.

The Palestinian economy depends largely on agriculture. Its contribution in 1999, combined with fishing, was 9.5% of GDP. This sector employs 12.7% of the Palestinian labour force and consumes an estimated 70% of total available water. The development of agriculture is under severe constraints in large part due to the lack of investment in irrigation and the resulting barriers to productivity. Compared to the 45% of land under irrigation in Israel, only 4% of the total land area in the West Bank is irrigated.

Institutional environment

In 1959, Israel passed its Water Law (amended in 1971 and again in 1991). Under its remit, water was defined as a national public good. This meant that all water, including waste, sewerage and runoff was the property of the state. The law also provided for the creation of the Water Commission, a permanent body to oversee and allocate water rights. At the head of this body is the Water Commissioner whose role includes the supervision of the National Water Carrier and the development of water projects. The government determined at the time of formulating this legislation that two-thirds of the 39 commissioners in the Water Commission would consist of 'public' representatives. Members of the commission are supposed to represent all water consumers in Israel, while the 'Agriculture Centre', the main lobbyist for the farm sector, is guaranteed 13 representatives. Initially, both the Water Law and Water Commissioner fell under the jurisdiction of the Department of Agriculture. Today, however, responsibility for both is shared by the ministers for Agriculture and for Infrastructure.

The official government body responsible for pumping and supplying 66% of Israel's water is Mekorot Limited. This public corporation is also empowered to undertake the planning and development of water resources. Much of the distribution and supply of Mekorot's water take place through the National Water Carrier. Substantive criticism has been levied at Mekorot. It has been accused of being a wasteful monopoly with no incentives to improve efficiency, cut costs or downsize (Plaut 2000). The traditional modus operandi has been to supply water at costs so low that they do not cover the actual costs of production. Each year the losses have been covered by substantial subsidies provided by the government.

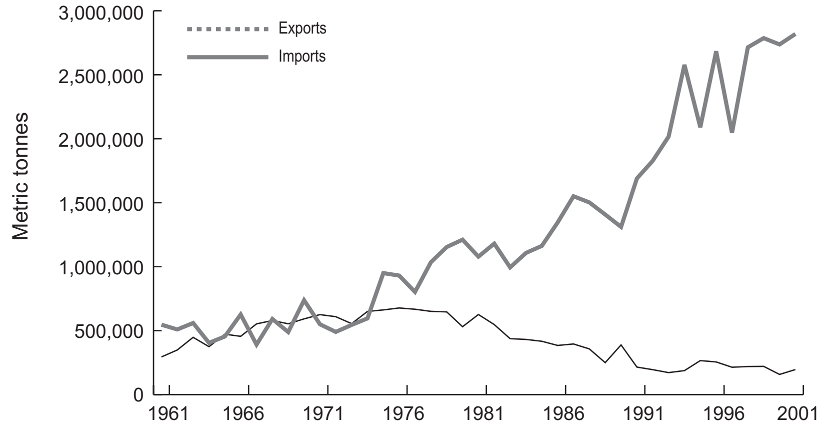
Israel successfully managed the transition from a largely agricultural-based market in the 1950s to a high-technology industrial economy in the 1990s. At the time of the shift, the Israeli economy was ripe for innovative policy measures, which would not have been acceptable in earlier decades. By the mid-1980s, Israeli agriculture consumed in excess of 70% of the country's available water, but accounted for a mere 3% of GDP and only employed a tiny proportion of the population. In contrast, industry and the services sectors utilised 5% of the economy's water while contributing 97% to GDP. The rapid rise in food imports as agricultural production declines graphically displays the economic shift taking place in the economy. This is of great significance not only in terms of annual water demand in Israel, but in terms of potential options for reaching agreement with a future Palestinian state over water-sharing (see figures 10 and 11).

By 1986, the US government had also started to press for radical reforms of the Israeli economy and specifically of its water management policies. At the same time, Israel's legislators were being heavily lobbied by environmentalists who criticised the government's management of the Sea of Galilee and the mountain aquifer under the West Bank. The situation was further compounded by the fact that the eastern Mediterranean region was experiencing a severe drought. The window of opportunity produced by this concurrence of factors, combined with the required political sanction, enabled a dramatic shift in allocation policy. The share of water to agriculture was reduced by 30%. In addition, the price of water to farmers was increased, improving the economic returns on water (Arlosoroff 1996).

After the occupation of the West Bank and Gaza Strip in 1967, a new water regime was implemented in the territories and authority over resources was shifted to the Civil Administration and subjected to Israeli water legislation. Institutional control over Palestinian water affairs was finalised in 1982 when water management was transferred to Mekorot. Water supply to the Palestinian population is currently deemed extremely inadequate. For example, inhabitants of the West Bank receive only 20% of the resources that originate in the subterranean basin. Many Palestinian villagers do not have access to running water and most of the older established wells have dried up, resulting in a reliance on distant wells and water tankers. Several other factors have compounded the already difficult situation. The current Intifada and the associated siege of Palestinian towns and villages by the Israeli authorities have resulted in an exorbitant price for water deliveries. Significant volumes of water are also lost due to the collateral damage brought about by shelling and the bulldozing of pipelines (see Deconinck 2002).

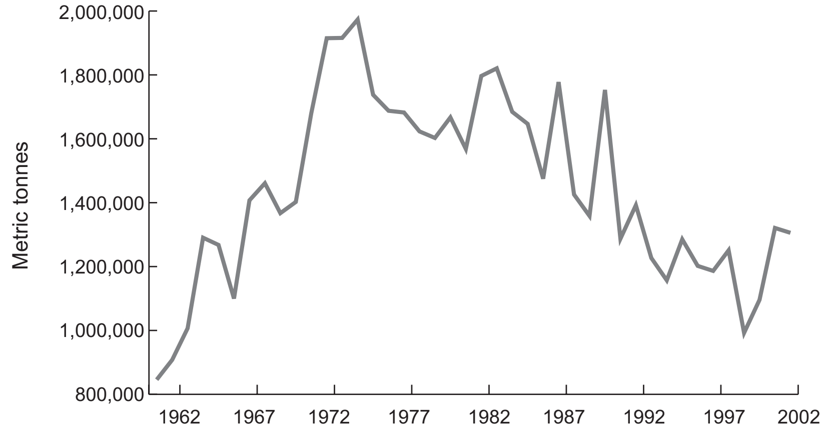
In terms of institutional structures and support, the water requirements of nearby Jewish settlements, located in contested land areas, have been sustained by the Israeli authorities. This has exacerbated conflict between the settlers and the Palestinians. Water installations and wells built in the Jewish settlements have physically impacted on Palestinian access to water and have understandably caused frustration. The disparate distribution of resources has had several ramifications. For example, in the mid-1990s, the entire Palestinian agricultural production received an allocation of 152 Mm^3 water annually from Israeli water institutions, compared to the 56 Mm^3 allocated to the 120,000 Jewish settlers.

FIGURE 10
Total agricultural trade for Israel, 1961-2001



Source: FAO 2003b.

FIGURE 11
Total agricultural production for Israel, 1961-2002



Source: FAO 2003b.

Palestinian authorities accuse the Israelis of shifting their water shortages onto the Palestinian people. Israeli authorities deny accusations of a ‘double’ water policy for Palestinians and Jewish settlers. Figures quoted by the government show a 20% increase in Palestinian water consumption under Israeli administration and Palestinian mismanagement is blamed for supply problems. Ecological damages to the mountain aquifer have been attributed to overpumping and infiltration by those living under the Palestinian Authority (Plaut 2000). However, the Palestinians attribute any accusations of mismanagement to the fact that they lack the necessary financial means to invest in water development and blame the Israeli occupiers for preventing the establishment of appropriate institutions. The inequalities experienced by the Palestinians are highlighted by the available statistics: the average per capita water consumption for an individual living in the West Bank is 35 m^3 while it is 321 m^3 per capita for an Israeli living either in one of the settlements or in the rest of Israel.

Policy options

In August 2000, the Water Commissioner submitted a Water Policy Plan to the Israeli government (implemented in August 2001), which set out a general framework for managing the country’s water resources in the next 20 years. The cabinet reconfirmed the contents of the document in April 2002 and approval was given for a transitional master plan for the water sector that would apply until 2010. The main aim of the plan is to conserve and manage limited natural water resources in the light of population growth and economic development.

The plan has already received some criticism, as calculations for allocations have been based on average rainfall and surface flow levels for the period (Deconinck 2002). This is based on the presumption that enough good rainfall will occur to compensate for those years when natural water stores will not be sufficiently recharged. Given that extraction figures from the coastal aquifer between 1980 and 1996 indicate that a water deficit existed for 11 of the 16 years, doubts are cast on the reliability of average figures. In addition, all projections in the plan are based on the assumption that an average starting point was in existence when the policy initiatives were put into effect. Unfortunately, instead of the anticipated levels, five successive years of below average winter rainfall between 1998 and 2002 resulted in depleted underground and surface reservoirs.

Actual freshwater consumption is expected to be 2,000 Mm^3 by 2020. Currently, freshwater consumption levels of 1,785 Mm^3 are beyond the sustainable yield of 1,555 Mm^3. This deficit is addressed through non-conventional water sources. In its water plan, the government clearly states its preference for desalination to alleviate future pressures and sets out a timetable for the construction of plants. These include the decision announced in early 2000 to build the first desalination plant near Ashkelon that would produce between 50 and 100 Mm^3 of desalinated water each year. It is projected that a new plant with a capacity of 50 Mm^3 will be built every two and a half years.

Reducing the cost of desalinated water in an economy like that of Israel enables new policy – and political – space to be created. This is true in both economic and security terms, the latter an issue of critical importance to Israeli policy. Cheap desalinated water would reduce reliance on West Bank groundwater, which would have both financial and political advantages. The peace builders among Israel’s political elite reason that it is in Israel’s interest to ensure that any future Palestinian state has sufficient water to survive. To this end, half the share of the mountain aquifer – some 200 Mm^3/year – would be sufficient for the West Bank’s needs at least for the next two decades. The resulting decrease in allocation to Israel could be met through desalinated water, of which the cost would be US $100 million (current estimates), a fraction of Israel’s GDP and about 1.5% of the annual import bill from the US (Shuval 2000). As mentioned above, water has been an important stumbling block to peace discussions between the Israelis and Palestinians. It is a firm belief held by many that any lasting negotiation between the two will need to incorporate arrangements for the equitable distribution and management of water resources.

Another option identified for future consideration in relation to the water policy plan is treated sewage water. This water will be targeted for use mainly in irrigation and it is estimated that approximately 830 Mm^3 should be available by 2020. One of the key policy directions is the increased emphasis being placed on the re-use of wastewater in agriculture.

As well as addressing supply issues, the government has been attempting to regulate demand, particularly from agriculture. In the late 1990s, a number of poor rainfall years culminated in a drought emergency being declared in April 1999 and an official enforced reduction of 40% in freshwater allocations to agriculture. This drought had a severe impact on Israel’s already dwindling cereal production, contributing to a decrease from 175,000 tonnes in 1998 to 159,000 tonnes in 1999. It was reported that, by mid-1999, nearly all of the country’s wheat crop had been destroyed by the drought.

The shift of water away from agriculture continues. In 2000, Israeli officials claimed to have moved 500 Mm^3 water from agriculture to the municipal sector and to have cut off some 70% of freshwater supply to agriculture. This shift has caused major conflict with farmers who sometimes use their political clout to lobby for increased allocations of water and who have even taken it upon themselves to solicit water officials in person. Even with these reductions, however, a substantial volume of water is still allocated to this sector. Although the proportion of agricultural exports has decreased in the last few decades, there has been an increase in exports in absolute terms. Figures quoted range from US $20 million in 1950 to US $666 million in 1991. The area under cultivation has risen from 408,000 acres in 1948 to 1.1 million acres in 1991.

This is reflected in the fact that, in 1999, 59% of water was still being allocated to agriculture.

No mention is made in the water policy report of any future plans for further reductions of agricultural water. It is clear that the position taken in the policy document is that of safeguarding agricultural productivity. It acknowledges the prominence of the sector within the economy and generally emphasises the government's unqualified support for agriculture. Some critics disapprove of the government's standpoint. For example, Deconinck (2002) argues that, if the consumption of potable water was 880 Mm^3 in 2002, 530 Mm^3 of high quality water, supplemented by an additional 620 Mm^3, will be required to maintain current production levels. In addition, local agricultural products sold outside Israel constitute an export of virtual water and an economic inefficiency. Other commentators go even further in stating that Israeli water policy, especially in terms of allocation, has been an unmitigated disaster (Plaut 2000). Due to government mismanagement and its wasteful, politicised administration, water policy has had a harmful impact on agricultural production and, it is argued, has even led to environmental destruction.

Even if the economy were to become more dependent on economic activity and a reduction in agricultural use would be realised, development in the industry sector would still require an increased input of water. The water plan document sets out the parameters for future water requirements of the industrial sector. Economic development, combined with rising birth rates and continuing immigration are expected to increase the volume of water required in 2020 by 60%.

Although the current Israeli water policy plan does not include any allowance for Palestinians living in the Gaza Strip (this area is not covered by the Israeli National Water System), it does, however, include proposed transfers of water to those living in the West Bank. If implemented, this will raise the average level of water consumption from 35 m^3 to 70 m^3 by 2020, resulting in an additional transfer of 115 Mm^3. This allocation, however, will not provide sufficient capacity to meet demands. The projected water estimates for the agricultural sector are 304.5 Mm^3 for 2010 and 415.2 Mm^3 for 2020. Even with a more equitable allocation of resources, those living in the West Bank will need to meet the deficit through treated wastewater. There are also suggestions that a restructuring of the sector is required with the introduction of crops tolerant to brackish water and appropriate intensive agricultural techniques.

If a time comes when Palestinians are able to follow Israel's lead and shift to a more industrial-based economy, adequate policies will then need to be implemented. Prior to the outbreak of the present Intifada, significant expansion plans were being contemplated for the industrial sector. Areas targeted for expansion were food-processing, quarrying and textile production. Many believe that one of the advantages of creating an industrial base for the Palestinians is the

opportunity it would provide for sustainable resource utilisation. Various innovative water conservation measures could be implemented early on in the process. These could include schemes for recycling water and processes for cooling and treating water onsite. Unfortunately, these policy developments have been put on hold as a result of current circumstances.

Israel is the only country in this study that has demonstrated an ability to cope with its water deficit through social adaptive capacity. This has been facilitated by its diverse and strong economy. At present, some estimates suggest that as much as 80% of all Israel's calorific intake is provided through the import of virtual water. Trade in food provides a vital way around the current dilemma of water stress. Future policy options for Israel and Palestine are closely tied to the surrounding political climate. Currently, there is little prospect of creative solutions to problems of water-sharing between the Israelis and Palestinians and to wider processes and actions to address the growing water stress.

According to expert estimations, the per capita water resource potential in Israel and Palestine was 250 m^3 and 115 m^3, respectively. These were projected to decrease to 153 m^3 and 5 m^3 by 2020 due to population increases. Both averages fall well below the WHO standard of 500 m^3 for severe water stress, but the situation of Palestinians is substantively more acute. As for desalinated water, 50 Mm^3 of water in this 'form' is currently being generated and the development of these operations is expected to increase substantially by 2020 (an estimated 395 Mm^3 of desalinated water is required).

Chapter Four
The resource environment in selected Southern African countries

This chapter investigates the water regimes of South Africa and Zimbabwe. Like the previous chapter, it illustrates conditions and constraints affecting the freshwater environments in these countries. The discussion of the country case studies follows the same pattern as applied in chapter 3.

South Africa

Water availability

South Africa covers an area of 1,221,000 km^2. The majority of the country is semi-arid with variable rainfall and high evaporation rates, which together result in low available runoff. Only 8.6% of rainfall is available as surface water, resulting in one of the lowest conversion rates in the world (Asmal 1998). There is high spatial climatic variability with three major precipitation regimes: a narrow winter rainfall season along the western and south-western coasts, continuous rainfall throughout the year along the south coast and a summer rainfall region elsewhere. South Africa experiences an average rainfall of 497 mm per annum, a rate well below the world average of 860 mm (Walmsley 1991). Nearly two-thirds of the country receives less than the national rainfall average and about 20% receives less than 200 mm. It is important to note that successful dryland farming requires 500 mm rainfall per annum.

The driest 70% of South Africa's land area, including the dry central plateau, contains only 11% of the exploitable water (Asmal 1998). Much of the plateau drains into the Orange River system, which flows towards the Atlantic seaboard. The Orange River catchment area incorporates 48% of the country, yet contributes only 22% (12.1 Mm^3) to annual runoff. The northern part of the plateau drains from Limpopo (formerly the Northern Province) into the Indian Ocean via the Limpopo River system. Rivers draining the eastern seaboard cover a mere 13% of the total land area, but account for 43% of the runoff. Only 25% of South Africa's rivers are perennial. However, due to the lack of inland reservoirs and permanent snow – features necessary to stabilise flow regimes – many are irregular and strongly seasonal (Asmal 1998). Groundwater resources can yield an estimated 5,000 Mm^3/year, representing about 15% of surface runoff, although this accounts for only 10% of total water use (De Villiers et al 1996). Relative to global averages, groundwater reserves are also limited in South Africa. The demand for groundwater increased from 1,790 Mm^3/year in 1980 to

Box 3
Southern African water issues

Southern Africa as a region is generally water scarce. For this reason a hydropolitical complex is said to exist, because transboundary water resources link different sovereign states into a set of international relations that are either competitive or cooperative in nature (see box 2). At a generic level, Southern Africa has six strategic water issues that are set to become more important in the future:

- Given the spatial distribution of water (see map in box 2), some states are better endowed than others. This means that the most developed states (South Africa, Zimbabwe, Namibia and Botswana) will increasingly look to water resources from outside their borders. Such international transfers of water are already – and will increasingly become – a distinguishing feature of Southern Africa.
- The natural temporal variation in water supply means that the conversion of rainfall to runoff is among the lowest in the world. In response to this, both South Africa and Zimbabwe have become major dam builders, being listed by the World Commission on Dams among the top 20 countries in the world by virtue of the number of dams in existence.
- Historic experiences relate mostly to the inequitable distribution of natural resources, with land and water being the most important. Water gives land its value, and the prime instrument of redistribution in South Africa is therefore the National Water Act. On the other hand, Zimbabwe has adopted an aggressive land redistribution policy in response to this historic inequity issue.
- Water scarcity is a fundamental limitation to the economic growth potential of the state. This is particularly true for the four pivotal states in the Southern African hydropolitical complex (see box 2) – South Africa, Namibia, Botswana and Zimbabwe. This makes access to and control over water a strategic issue.
- As a result of the combination of the history of the liberation struggle and various civil wars in the region, there is a need for post-conflict reconstruction in which water plays a significant role.
- As a direct result of the strategic significance of water resource management in Southern Africa, particularly in light of the mooted hydropolitical complex (see box 2), transboundary rivers can become major drivers of regional integration. As such, this has the capacity to become a key component of the New Partnership for Africa's Development (NEPAD), or any other regional economic development initiative.

approximately 2,000 Mm^3 in 2002, with 78% of this resource currently allocated to the irrigation sector (Basson et al 1997).

Demand for water does not coincide with the spatial distribution of the resource. The highly disproportionate water distribution forced the apartheid government to undertake an extensive system of water transfers from the wet coastal strip to the highly populated and industrialised dry inland centres (DWAF 1986). These schemes were implemented in order to facilitate industrial development (particularly mining) and also to provide the rapidly expanding urban areas with sufficient water. Localised water deficits in centres of growth and expansion continue to be a problem in present-day South Africa. Demand exceeds supply in many catchment areas and there is increasing pressure for supplementation from water-rich areas (see the Lesotho Highlands Water Project below). By 2030, it is predicted that at least seven river basins will be in deficit and will not be able to meet their water budgets (Basson et al 1997).

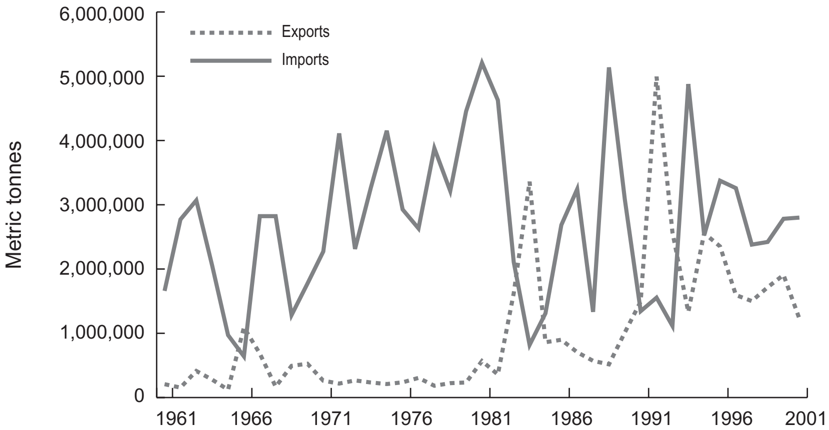
Given the inadequate and erratic rainfall over South Africa, only 13% of the land surface is suitable for arable farming. According to World Bank statistics, this ceiling was almost reached in 2000 when 11% of the total land area was under major cropping. Drought, however, has a major impact on the agricultural economy. Maize, the most important item in South African farming, is widely affected in drought years. Following the 1983/84 drought, maize production was at 3.4 million tonnes, down substantially from the 13.6 million tonnes of 1981/82. Further droughts in the late 1990s also resulted in significantly diminished output, but by 2000 maize production began to improve and production levels were registered at 10.6 million tonnes. Real GDP in the agricultural sector declined by 3.1% in 1998 due to drought conditions, but it recovered by 1999 and grew by 4% in 2000.

By the mid-1990s, irrigation accounted for 50% of total water use. Irrigated crops were grown on only 10% of the cultivated land, but provided 35% of domestic foodstuffs and 85% of agricultural exports (DWAF 1999a). Private farmers and Irrigation Boards farmed 80% of the total irrigated area (De Villiers et al 1996). Water rights under the apartheid regime were linked to land ownership, skewing the distribution of water resources towards the white minority population.

With the freshwater resources of South Africa severely stressed (Davies et al 1993), more than 50% of wetland areas have been lost to land-use practices and many floodplains have become less productive. Most of the country's major rivers are regulated and major dams are fully extended with a combined capacity of 50% of the total mean annual runoff (Asmal 1998). Water scarcity is further exacerbated by the pollution of both surface water and groundwater resources. Typical pollutants affecting these supplies include agriculture runoff, domestic and commercial sewage, acid mine drainage and industrial effluents, although it

FIGURE 12

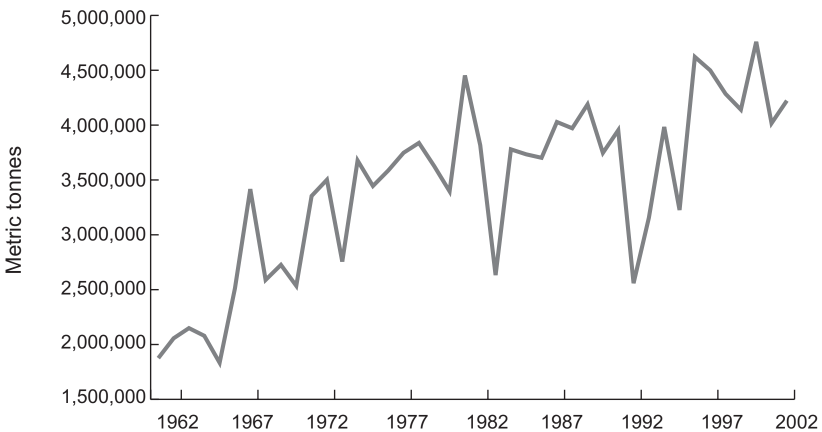
Total agricultural trade for South Africa, 1961-2001



Source: FAO 2003b.

FIGURE 13

Total agricultural production for South Africa, 1961-2002



Source: FAO 2003b.

is extremely difficult to quantify the volumes and types of pollutants entering the water system (State of the Environment Report 1999).

Socioeconomic issues

The population of South Africa was estimated at 44.8 million in 2001. According to the 1996 census, 8.9% of the economically active population were engaged in agriculture. This figure represents a sharp decline from the 28% recorded for this sector in the 1970 census. The nature of the economy is changing fast. In 1999, official figures placed manufacturing's contribution to GDP at 21%, compared to 6% for mining and quarrying and only 3.7% for agriculture. By contrast, the burgeoning services sector contributed two-thirds of GDP in this year, representing one of the largest shares in Africa.

The rate of growth in agricultural production has decreased over the past 20 years (see figures 12 and 13). There has also been a shift in the way water is used within the agricultural sector, with a swing towards the production of high-value crops, specifically for the export market. For this reason, it is likely that the sector will continue to be a relatively important employer in years to come. It is quite possible that there will be an increase in both agricultural imports and exports, as local production is geared towards high-value fruit and horticultural crops for export, while cereals are bought on the world markets.

Patterns of water use and management issues in terms of access to water are embedded in South Africa's political history. The principal focus of the apartheid government was the bulk supply of water to the commercial farming sector and to various industries. This emphasis left between 12 and 14 million people without access to formal water supplies (DWAF 1999a). In addition, 21 million people out of the total population of 41 million had no formal sanitation. Not surprisingly, most of these people lived in the former homeland areas where 75% of the population lived on a mere 13% of land that are mostly water deficient.

According to Basson and others (1997), the next 30 years will see an anticipated 51.7% increase in the demand for water. Given that current freshwater resources are almost fully utilised, it is unlikely that future water resource demand will be sustainable with the present rates of economic development and projected population growth rates (State of the Environment Report 1999). Many predict that water supplies will become a major constraint in the country's socioeconomic progress (see, for example, Asmal 1998; Ohlsson 1995).

Institutional environment

In 1998, the new National Water Act 36 of 1998 was promulgated to replace the Water Act (no 54) of 1956. Under the older legislation, the right to abstract water was principally riparian, and "abstraction by riparian landowners was not subject to limits unless formally apportioned by a Water Court among different users of the same stream, or regulated by a government Water Control Area or an Irrigation Board" (Woodhouse & Hassan 1999). In addition, groundwater and surface water located on private land were the gratis property of the landowner. 'Homeland resources', in contrast, were communally owned and fell under the control of tribal authorities. The government provided block water allocation to each homeland administration's agriculture authority. African farmers requiring water resources from their local irrigation boards were referred to the Department of Water Affairs and Forestry (DWAF), where the usual response was that there was no water available as it had already been allocated. They were expected to apply for additional resources from the already over-extended homeland allowance. In the white areas, irrigation boards distributed water to their membership (mainly white commercial farmers) and levied management charges. Where these areas were supplied through government water works, the boards were responsible for collecting tariffs on behalf of the government. The old irrigation boards were also responsible for water distribution within government water control areas – areas where the government had asserted control over all water abstraction.

The 1998 National Water Act falls under the authority of the Minister of Water Affairs and Forestry. In conjunction with the Water Services Act 108 of 1997, it is one of the most important pieces of legislation on water resources. The two acts abolished riparian rights and the distinction between 'private' and 'public' water. Water was effectively nationalised and "all water in the water cycle whether on land, underground, or in surface channels, falling on, flowing through or infiltrating between such systems became an 'indivisible national asset' over which the national government would act as custodian in the public interest" (DWAF 1997). Another key aspect of the legislation was the establishment of a national water reserve that prioritised human and ecological flows over flows to agriculture or industry (Asmal 1998). This provides for the rights of access to basic water supply and sanitation and the institutional structures essential to water provision (State of the Environment Report 1999). In addition, the legislation saw a simplification of water resource management and the development of multiple stakeholder catchment management agencies. The two acts have brought principles of sustainability of use and equity of distribution into law. A third piece of legislation that affects water resources is the Minerals Act 50 of 1991. Although indirectly related, it has important implications for the water environment, specifically groundwater. The act requires that every operating and prospecting mine produces an environmental management programme report (EMPR).

Underlying the water reforms in South Africa during the 1990s was the major political aim of redistributing water to promote social efficiency between alternative and possibly competing demands. To this end, 19 water management

areas (WMAs) were established, each governed by a catchment management agency (CMA). The responsibility of the CMAs was to meet the demands for the resource, while at the same time providing scope for greater public participation in management. At a subsidiary level, water users associations (WUAs) were set up to promote further devolution of water management. It was determined that the administration of water at the subsidiary level would need to recognise and address conflicting interests between users and that the principle of subsidiarity "should not interfere with the need for a national perspective on water use" (Asmal 1998).

In keeping with similar activities in other Southern Africa countries, there was an emphasis on extending management reach, essentially to achieve "a balance among the interests of water users, potential water users, local and provincial government and environmental interests groups" (National Water Act section 81). Each CMA was to be financed through management charges payable by all water users in the catchments. The core functions of the CMAs were to:

- investigate and advise on the protection, use, development, conservation, management and control of water resources in a particular WMA;
- develop a catchment management strategy; and
- coordinate the related activities of water management institutions within a particular WMA.

Unfortunately, many CMAs are still in the process of being established and until they have been put in place the intended benefits of the scheme will not be realised.

Those operational WMAs with fledgling CMAs have experienced teething problems. A study of one of the early transitions to CMA management, carried out in the Komati River area, highlights the problems of legitimacy and the difficulty encountered when attempting to undertake the level of stakeholder involvement called for by the Water Act (Woodhouse & Hassan 1999). Firstly, there is no clarification of the extent of water available to farmers, and all three providers – the DWAF, the Irrigation Board and the Department of Agriculture – have avoided taking responsibility for this issue. Secondly, African farmers are concerned about dependency, and as the 'junior' members of the Irrigation Board also about the dominance of the larger, white commercial farmers. Part of the problem in adapting the irrigation boards to reflect the multiplicity of stakeholders has been the existing finance structures that rely on member levies to pay for operational and maintenance costs. Many smaller farmers, however, cannot afford to contribute and this has implications for the distribution of power within boards. It also hampers the development of both capital works and effective administration.

Political challenges are also evident in terms of the development and distribution of water for domestic use. Prior to the 1994 White Paper on Community Water Supply and Sanitation, there was no 'political mandate' to provide a domestic water supply to households (Abrams 1996). Under the new regimes basic water services are considered as human rights. After 1994, the DWAF became responsible for water and sanitation services in the former black homelands. This had previously been the responsibility of the rural service councils (RSCs). Cost recovery for the mostly inadequate water provision under the RSCs was largely unsuccessful, not least because failure to pay water bills provided an effective outlet for political opposition. The 1994 white paper signalled a major shift in domestic water provision. The aim was to facilitate a move from a supply-led system to a community-based, demand-driven approach to water and sanitation. Water was to become an economic good and the 'user pays' principle (for ongoing costs) was to be employed (Waddell 2000). The Local Government Act makes the provision of water the responsibility of local governments in the long term. They have until 2007 to provide all households with a water supply and, at the same time, ensure the successful maintenance of water bodies and systems. This is a heavy political commitment given the scale of the task.

Although the commitment to a demand-driven water policy appeared strong after the 1994 white paper was published, there has since been a substantial shift in narrative back to a supply-driven, basic needs approach. The provision of free water to rural communities became a strong political slogan in late 2000. The DWAF announced that it planned to provide 6,000 litres of free water to each rural household every month. This service was included in the "free basic amount of water, electricity and other municipal services", which formed part of the African National Congress (ANC) council election manifesto. The promise was greeted enthusiastically in literature of the Mvula Trust (an NGO), where it stated that "[g]overnment's new policy on free basic services will help municipalities ensure that all citizens enjoy the socio-economic rights which our Constitution guarantees. It is a big step forward in the struggle against poverty. Ensuring a basic amount of services free to the poor also empowers municipalities to enforce payment from those who are less poor. In the past enforcing credit control measures has been hampered by opportunists using the plight of those who genuinely cannot afford to pay, to avoid paying themselves" (Mvula Trust 2001).

Implementing a free basic service is extremely complicated. It will be difficult to ensure that those who consume more than the basic volume allowed pay for the additional usage. The government will need to create effective metering, billing and credit control systems. This is not an easy task. For example, in areas where water is provided by public standpipes, metering is expensive in relation to the relatively small income that can be raised from this type of service. In such cases, waiving all charges may make more sense.

South Africa has also been involved in several bilateral projects. By far the largest and most controversial has been the Lesotho Highlands Water Project (LHWP). A project agreement was reached between South Africa and Lesotho in 1986. It involves the building of six dams on the upper reaches of the Senqu-Orange River and the establishment of 200 kilometres of tunnels. Once all three main phases have been finalised in 2021, an anticipated 2,200 Mm^3 of water will be transferred annually to the Ash River, a tributary of the Vaal River. The aim is to meet the water demands of Gauteng, the province that houses South Africa's industrial heartland (an area roughly similar to the former Pretoria-Witwatersrand-Vereeniging (PWV) mining and industrial region). The project is likely to earn R130 million a year for Lesotho based on sales of electricity and water to South Africa. In addition, it will enable Lesotho to become self-sufficient in power generation.

Policy options

The advent of democracy in South Africa in 1994 provided a window of opportunity for the new government to formulate policy that could promote sustainable development while providing basic rights for each citizen (State of the Environment Report 1999). The Constitution of 1996 has placed South Africa at the forefront of policy initiatives for developing countries. An important policy aim is the protection of the environment and an elimination of resource abuse, inequity and the degradation of systems. Prior to 1994, resource allocation (including water) had served a narrow group of the population and selected sectoral interests. Current environmental policy seeks to redress the bias while urging the public to utilise resources sustainably. It encourages public input in policy and actively seeks consultation with civil society.

South Africa faces a number of major challenges to future water use and national food security. It is a highly rainfall dependent country within a highly variable region. Nevertheless, it has developed effective alternative strategies – principally through massive industrial and power development – which can help to ameliorate future agricultural demand for water.

Several options for increasing water supply are under investigation in South Africa. These include importing water from high-flowing Southern African rivers, for example, the Okavango and Zambezi. Although currently too expensive, desalination may also be a viable future option for some coastal cities. However, it is recognised that demand management has the potential to provide the best opportunity for dealing with water scarcity. Water pricing, which is already part of the water policy, and the creation of a new culture of payment are considered to be key factors in a demand management approach.

Future water development policy must also ensure that the living standards of formerly disadvantaged communities are improved and must continue to provide efficient supplies to important urban centres and industrial areas. Key environmental flows are also a priority.

Table 2
River basin cooperation between South Africa and neighbouring states: Committees and authorities

Committees and authorities	Countries involved
Tripartite Technical Committee	Mozambique, Swaziland, South Africa
Limpopo Basin Technical Committee	Botswana, Zimbabwe, Mozambique, South Africa
Trans-Caledon Tunnel Authority	Lesotho, South Africa
Komati Basin Water Authority	Swaziland, South Africa
Vioolsdrift Noordoewer Joint Irrigation Authority	Namibia, South Africa

Source: National State of the Environment Report 1999.

South African policy is further influenced by the international community. The country is a signatory of various international conventions and agreements (State of the Environment Report 1999). These have implications for national strategies, policies and implementation plans. Of increasing significance is the level of regional integration and cooperation in managing the numerous shared river basins (see table 2). This includes developing strategies that will support disadvantaged communities in South Africa while maintaining small-scale agriculture in neighbouring countries.

Zimbabwe

Water availability

In 1980, Zimbabwe emerged from a period of post-colonial domination by a white minority with the promise of rapid economic development for the majority black population. The post-independence government inherited an economy heavily biased towards commercial agriculture, which was mostly dominated by white farmers. Water policy, control and legislation had also been closely allied with the system of production. Since the late 1980s, however, a process of water reform has taken place, in part promoted by the effect on the economy of droughts in the 1980s and 1990s. During the late 1990s, the water reform process became entangled in the political issues surrounding wider development objectives. Most notable of these have been the issues of land reform and the return of commercial farming areas to smallholder agriculture.

Zimbabwe's land area of 391,000 km^2 ranges from a high plateau to several low river valleys with mountains in the eastern highlands. In common with much of the Southern African region, there is high rainfall variability. About 90% of precipitation occurs between November and March. Any significant variation in pattern or location has enormous repercussions for the production of maize ('mealie-meal'), the country's staple food. The location of major maize production areas reflects the pattern of spatial precipitation, from an annual average of 1,400 mm in the eastern highlands to 800 mm in the north-eastern highveld and just 400 mm in the Limpopo Valley. The optimal, commercial food production area is concentrated on the soil-rich, rainfed plateau. The lowveld (the site of highly populated communal lands) is an arid soil-poor environment unsuitable for extensive agricultural production. Given the relatively low cultivation potential of these areas (and, in fact, most of the country), the production of food on commercial farmland is especially important.

Major rivers on the border of the country are the Zambezi to the north, the Limpopo to the south and the Save to the east. According to the FAO, annual internal renewable water totals are approximately 14,000 Mm^3 of which 30% is currently utilised. Added to this is an annual groundwater potential in the region of 1,000 to 2,000 Mm^3. Although a small resource, this forms a disproportionately important source of water for poor rural communities in the drier lowveld.

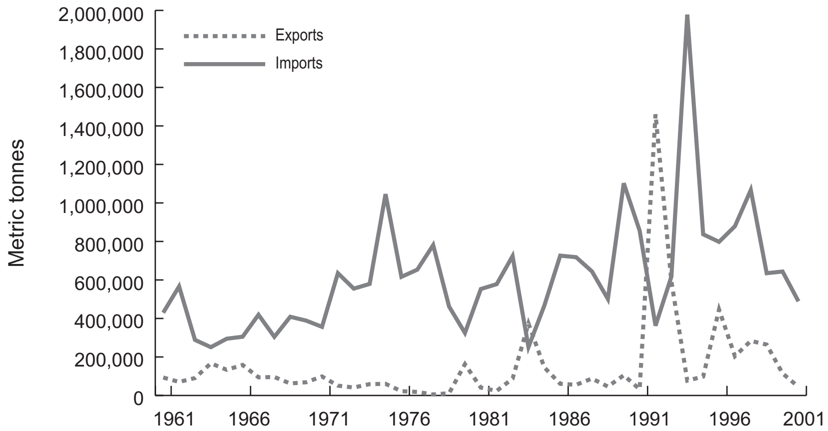
In contrast to South Africa, Zimbabwe depends far more on its agricultural sector. Effective management of the country's water resources is therefore a key national requirement. Currently, agriculture utilises 80% of the total renewable water supply, with industry and mining using 5% and the remainder allocated to the domestic sector.

The development of supply structures is such that most of the water used in Zimbabwe comes from surface dams, of which 90% is allocated to agriculture. The construction of dams has largely served the commercial sector while also providing water to major urban areas. Very little past supply development has explicitly sought to increase the agricultural potential of communal areas, with the possible exception of irrigation in the south-east lowveld where it was intended for people to be resettled from higher density areas.

Socioeconomic issues

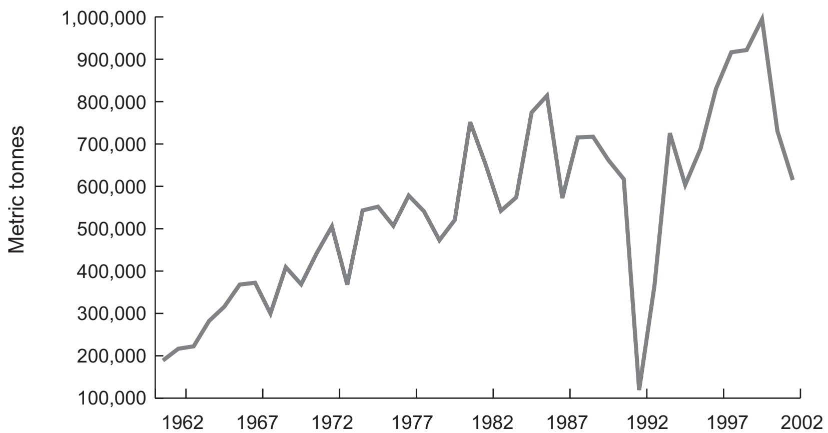
Zimbabwe's socioeconomic structure began to change rapidly during the period of this study. From an era of economic dominance by a small, largely white commercial farming elite, the economy has been radically restructured with a fast-track land reform process. In effect, this has dismantled the commercial farming sector and returned land to African smallholders. The process has been highly controversial and has received enormous media coverage both in Zimbabwe and abroad. It is still too early to determine the effect of this situation

FIGURE 14
Total agricultural trade for Zimbabwe, 1961-2001



Source: FAO 2003b.

FIGURE 15
Total agricultural production for Zimbabwe, 1961-2002



Source: FAO 2003b.

on the long-term water economy. At present, however, evidence suggests that it is having some impact on the efficient operation of new management institutions and on the effective environmental management of water and land. There has also been a reduced capacity in the generation of water revenue from the sale of permits and the levying of charges, most of which were previously obtained from the commercial sector.

Zimbabwe's population was officially estimated at 12.3 million in 1997. This figure is twice the size of the population of each of Israel and Jordan, but only a quarter of South Africa's. Population growth estimates suggest that, with the present growth rate of 3%, the population will reach 15 million by 2006 and 20 million by 2016 (Moyo et al 1993). The high growth rate combined with what is possibly a rapidly declining long-term food production scenario suggests two possible outcomes:

- the demand for water will be substantially reduced in agriculture; and
- production will increasingly depend on rainfall patterns.

There is a possibility, therefore, of far greater vulnerability in the short to medium term. Although the current food crisis in Zimbabwe has been ascribed by government officials to drought , the food production deficit may be an indication of future structural problems. Figures 14 and 15 illustrate, among others, the impact of climate on the economy. In 1992, a severe rainfall deficit resulted in the substantial decline of agricultural production and increased imports of food staples. The following season, however, the rains returned and a bumper crop was recorded.

Figures for 2000 indicated that two-thirds of the total labour force and about a quarter of the formal sector labour force were engaged in agricultural activities. In contrast to the other three countries under review, Zimbabwe's agricultural employment figures of between 16 and 17% have remained roughly the same since 1980. Maize is the most important food crop in Zimbabwe and in 1996, farmers produced some 2.6 million tonnes. The 1998 season produced only 1.42 million tonnes due to the effects of drought and the decline in the cropping area. The immediate impact of the land reform process on maize production is evident in the 2001 crop figure, which was recorded at 1.5 million tonnes. This figure was 28% below the previous year and well below average despite the year's good rains. The decrease was attributed to the huge reduction (by more than half) in the area planted on large-scale commercial farms. The effects of both the land reform policy and the present economic contraction are also clear in figures 14 and 15. Production of the principal food and non-food crops has decreased, coupled with a drop in the exports of these crops. Due to the lack of foreign capital in the country, there has also been a decrease in imports of agricultural products.

In 2000/2001, food import needs reached 579,000 tonnes. The World Food Programme has described the government's ability to import maize as 'extremely limited' given the substantial decline in gold production and the reduced tobacco harvest (another factor of the rapid land return policy). This has led to a significant reduction in necessary foreign exchange earnings, much of which has been earmarked for other energy imports and international debt servicing. It has been suggested that Zimbabwe's economic situation and ability to feed itself have less to do with water availability and more with the changing structure of agriculture. Given that water management was closely tied to the colonial structure of agriculture, it was likely that significant consequences would arise when the new land use and commercial agricultural reforms were implemented. These issues are explored in more detail in the following section.

Institutional environment

The pre-independence Southern Rhodesian Water Act of 1976 linked access to water with access to land. Ownership of land resulted in rights to water, with both resources granted in perpetuity. Major water institutions of the time, including the Irrigation Department, existed mainly to support the extensive, white-dominated, large-scale commercial farming sector. Institutions were largely concerned with supply infrastructure such as dams. In communal areas, water structures and systems were used to open up development in the Zambezi, Limpopo and Save River valleys.

The 1998 Water Act, which came into force in January 2000, adhered strictly to the prescriptions of international water policy. In particular, the act reflected the global integrated water resource management paradigm. In terms of legislation, the Water Act led to the establishment of seven catchment councils. Each council was responsible for the management of a major catchment area, which it achieved through various lower level sub-catchment councils. Instrumental to the success of these new institutions was the Zimbabwe National Water Authority (ZINWA). A key element of this new authority was its financing structure. ZINWA was regarded as a commercial, self-funded entity, responsible for its own operational costs and infrastructure charges. At microlevel, the aim was to raise funds through sub-catchment council levies and charges. Although the price of water was raised for some consumers to meet commercial operation criteria, it was anticipated that targeted subsidies to vulnerable groups could be implemented through a pricing mechanism. A national 'blend price' was fixed for water, which applied across all regions of the country regardless of relative water availability. Primary water use – water necessary for sustaining livelihoods – was provided free of charge. However, determining the precise definition of the term 'primary water' has posed several problems and has led to conflicting interpretations. At macrolevel, ZINWA was expected to contract commercial loans for capital development (ZINWA 2001).

Alongside the newly devolved water structure was an accompanying focus on widening stakeholder participation in management processes. This was considered a crucial part of the restitution process. The revised system dictated that all categories of users had to be represented. However, in reality, control remained with the large-scale, predominantly white commercial farming sector. This was partly by design and partly by default. Council meetings often took place in remote and inaccessible venues, out of the way for those stakeholders coming from communal areas. In addition, the language barrier – most meetings were held in English – coupled with the lack of technical knowledge made the actual inclusion of all stakeholders somewhat difficult.

Regardless of these problems, catchment councils have an extremely wide remit of responsibility. These range from drawing up management plans for river systems, through approving applications and granting permits for water use, to regulating and supervising water utilisation. Additional functions include supervising the performance of sub-catchment councils and resolving conflicts among users. Although catchment councils have been assigned extensive local level responsibility, they have in effect been largely preoccupied with establishing systems of tariff collection and managing their own finances.

Future major challenges facing these institutions include the management of the complex arrangement of supply constructions. These include irrigation systems, water transfers, dams and the many small reservoirs constructed by NGOs during and after the major droughts of the early 1990s.

The interface between the institution as a vehicle for management and the farmer as resource user occurs at the sub-catchment level. Each sub-catchment council is tasked with supervising the exercise of permits (including those for groundwater use), monitoring flows, electing a representative to the catchment council, providing technical expertise, data collection, management planning and the collection of rates and fees. Difficulties in assuring local stakeholder involvement have also been encountered at this second tier. Appeals have been made for a further level of decision-making and water users associations (WUAs) have been suggested as a useful mechanism. In Mazowe District, where the initial sub-catchment council was piloted, a WUA was successfully instituted to provide adequate, representative stakeholder decision-making.

Policy options

Following Zimbabwe's independence, the government embarked on policies that sought greater rewards for the black majority population, most of whom were concentrated in the communal areas of the country. Initial efforts were focused on increasing the water supply to households and little immediate attention was paid to the provision of water to farming. However, as the 1990s progressed, and particularly following the severe drought of 1992, renewed attention was paid to the country's agricultural water 'inequity'. Demands were made for a change to the system based on riparian rights and resource rights granted in perpetuity.

There was a push for a rights-based system where access to water could be translated into time-bound permits.

Future augmentation of water supplies in Zimbabwe is constrained by the transboundary nature of the resource. Development on any Zimbabwean river system has implications for downstream users, a factor that constrains the country's own irrigation expansion options. In addition, there are fears that the government lacks the proper capacity for the necessary water restructuring and reform. The current major agricultural transition has placed the commercial farming sector in jeopardy. The implications of the decline of this sector are as yet unknown. However, there will be large-scale effects on water management and demand management policy processes. On the one hand, managing water demand will become a more complex task as there will be many more smaller users. On the other hand, the transition to smaller farmsteads will likely result in a lower overall abstraction of water given the relatively low technical capacity of resettled farmers. The changes in land-use practices will also have possible environmental impacts within basin catchments. The worst-case scenario includes predictions of increases in sediment load caused by rapid soil loss, as previous rangeland is ploughed and forest cover lost to firewood and construction materials for resettlement areas. While much of the discourse on environmental 'damage' is politically loaded, there is already anecdotal evidence that small and medium-scale dams are fast filling up and storage capacity is being lost. If this is true, the impacts of such a scenario are most likely to be felt in poor rainfall years when demand and available supply are at variance in many areas.

Certainly, Zimbabwe is an example of politicised decision-making with respect to agricultural production, but this has not yet filtered down to catchment and sub-catchment levels. If the current situation remains the same, the demand for water is not likely to increase substantially, but the capacity to produce food internally will most likely be severely constrained. The future is beginning to look particularly bleak, with the number of available policy options increasingly limited.

Chapter Five
Supporting policy options for the Middle East and Southern Africa

A golden thread that is common to all four case studies presented in this report is the existence of a high level of complexity that forms the backdrop to water resource management under conditions of endemic scarcity. This complexity has a number of root causes, and it has major ramifications in the context of policy options in water-stressed states. In fact, this complexity can be regarded as one of the core policy-related issues for water-stressed states for four main reasons.

Firstly, complexity means uncertainty in a wide variety of manifestations. There is economic uncertainty when secure access to water resources as a fundamental input into the economy is not assured. Given that state power is closely linked with economic capability, this tends to drive the process of the securitisation of water resources under conditions of water scarcity (Turton 2003). Then there is ecological uncertainty, which arises from the non-linear responses by aquatic ecosystems as they approach, or even pass, the point of sustainable abstraction. In Southern Africa, for example, one specific element of this complexity is related to the mining industry, where mines have reached the end of their economic lifespan and are being shut down. In many cases, this leads to mine flooding and the subsequent decanting of a cocktail of toxic substances ranging from arsenic to sulphates, accompanied by high levels of acidity – a condition known as acid mine drainage. This water enters the river systems from diffuse points, making it difficult to control. The situation is exacerbated by the fact that rivers are already over-abstracted, with limited dilution of this toxic effluent, resulting in a situation that is extremely complex to manage. Given that the four countries under discussion all have substantial populations that need to sustain livelihoods from ecosystems in one form or another, this is a major issue. Finally, political complexity has a number of root causes, all of which tend to be amplified as water scarcity increases. The Southern African hydropolitical complex (see box 2) is an example of the political inter-connectivity that arises when a country's economic growth and development suffer as a result of water scarcity. Similarly, the political demands of social groups that are dispossessed through the process of resource capture is but another manifestation of this political complexity, becoming a potential driver of social instability in its own right.

Secondly, complexity in all its ramifications means uncertainty. This arises from the multivariate nature of the problem, particularly when an ecosystem collapses, a condition that is often accompanied by dramatic short-term change as non-linear responses kick in. A particularly interesting element of uncertainty is a direct result of attempts to manage uncertainty in the first place. An example from this study is the ecological consequence of dam construction and the interbasin transfer (IBT) of water, which takes a long time to manifest itself, but once evident is extremely difficult to remediate. Manifestations of dam building and IBTs are the loss of biodiversity, the loss of keystone species, the introduction of non-indigenous alien invasive species, salination, the capture of silt and the ravages of scouring as a result. This phenomenon has been labelled the 'revenge effect' (Tenner 1996).

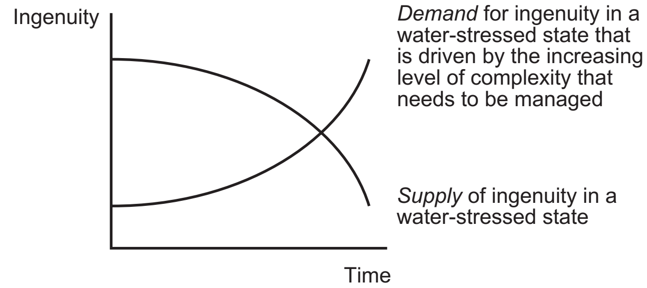
Thirdly, complexity means risk, again with a wide range of manifestations. Given the fact that, by definition, complexity means that the isolation of variables is difficult, and the profound understanding of the linkages between those variables is impossible, complexity breeds complexity, and with this proliferation comes risk. One element of this risk arises from the revenge effects of the policy options that were selected to remedy previous manifestations of complexity. Another element relates to political risk, particularly as the patronage associated with water allocation is undermined and the gate-keeping elite experience a gradual erosion of their authority. This condition is often exacerbated by the demands of the dispossessed.

Fourthly, complexity places a great demand on the institutional capacity of water-stressed states. To state this in terms of complexity theory, the increased complexity of the world requires greater technological and institutional complexity (Homer-Dixon 2000). This places a great burden in two specific areas. On the one hand, increasing levels of complexity and associated risk place a significant demand on scientific expertise and technical ingenuity. This is magnified when states compete for a dwindling shared water resource such as a transboundary river, and is manifest as different levels of scientific and engineering capacity, which can be interpreted as a form of hydropolitical arms race with dams and IBTs as the weapon of choice. Technically more advanced societies will triumph in this race, as the resource base of their weaker rival is captured and redistributed in the form of political patronage. On the other hand, increasing levels of complexity and associated risk place a huge burden on the development of institutions and, in particular, on the development of policy options as a product of those institutions.

Seen in terms of these four elements of complexity, the situation confronting water-stressed states can be described as one in which an increasing demand for ingenuity is accompanied by a decreasing supply of ingenuity over time. This is illustrated in figure 16.

The demand for ingenuity has two distinct components (Homer-Dixon 2000). Technical ingenuity is needed to develop engineering solutions. Social ingenuity is needed to negotiate agreements between competing stakeholders, to develop viable policy options, and to sustain the political legitimacy of the various institutions that are used for these tasks. This demand for ingenuity

FIGURE 16
Ingenuity over time in water-stressed states



typically increases over time, probably at an accelerated rate in water-stressed states because of the increasing levels of complexity that arise under those specific conditions. The supply of ingenuity, on the other hand, tends to decrease over time, often in a non-linear pattern, as institutions are overloaded, as the so-called 'brain drain' occurs due to the attraction of young talent to centres of opportunity abroad that are perceived to be better, and as the hydropolitical 'arms race' is slowly lost by the economically weaker stakeholder.

The net result of these combined elements of complexity, risk and uncertainty is the fact that decision-making in water-stressed states is almost always conducted under conditions of uncertainty. This is the core problem that has been identified in this study. Policy options in water-stressed states are always developed under conditions of extreme uncertainty, and almost always within an institutional context that is under severe stress.

Broad-based ideas such as 'virtual water' allow decision makers to understand the existence of different macro-options in one decision-making area, for example, the allocation of the resource between sectors to reduce sectoral water stress due to excessive water use in agriculture. The simple logic of alleviating stress at national level through seeking often cheaper alternatives to the domestic production of food on the world market has clearly worked in some of the countries under review in the current study. For example, Israel has succeeded in the last few decades, as much out of necessity as policy choice, in reducing overall water usage in agriculture.

Nevertheless, there are important concepts of development that tease such water management – and 'virtual water management' – strategies away from the simple economic choice between water in agriculture or higher value usage in industry. Certainly, the issue of poverty elimination underscores the importance of livelihoods based on agriculture in the contexts of, for example, Zimbabwe in Southern Africa and Palestine in the Middle East. In these countries, the realities of shifting water, or the pursuit of economic strategies that result in water demands being shifted between sectors, are tied to wider political imperatives and closely associated with land and land rights.

The existence of a hydropolitical complex in Southern Africa shows how water-stressed states are linked in a complex matrix of international relations that range from potentially conflictual to potentially cooperative. The pivotal states all face a dismal future if secure access to water is not ensured, or more importantly, if alternative options are not developed for the more beneficial use of the existing scarce resources. This in turn raises the notion of second-order recource scarcity, to the extent that the capacity to mobilise second-order resources in sufficient quantities at the right moment in historic time becomes the independent variable in any policy equation. This means that policy options in water-stressed states are not only about mobilising water as a strategic natural resource, but also about developing alternative policy options. This is the major challenge.

As the case of South Africa has shown – and Zimbabwe to a lesser extent – complex arrangements can be developed to help augment supplies and distribute scarce resources where there is effective institutional and social adaptive capacity. However, in the case of South Africa, the adaptive capacity was in fact largely 'partial', at least until the end of the apartheid era, because the nature of capacity and adaptation was fairly limited to a narrow section of society, which the bulk of the changes sought to benefit. The complex arrangements enabling South Africa to transfer water from Lesotho to water-short Gauteng were model institutions in the 'era of certainties' before the 1980s (Swyngedouw 1999a; 1999b), but subsequent to the end of apartheid, these arrangements were viewed with less enthusiasm. South Africa has an economy with the adaptive capacity to engineer interbasin water transfers. The country has the additional capacity to build institutions that could manage water in both an economically efficient manner and in a way which achieved environmental services goals. By the 1980s, the green movement had questioned the certainties underpinning the hydraulic mission of the state. The control of nature brought uncertainties rather than certainty (Reisner 1993) and within these changed circumstances, projects such as the Lesotho Highlands Water Project (LHWP) are currently being re-evaluated. The FoRWaRD decision support model (see appendix A) is a tool that can be useful in this endeavour, as it can help develop an understanding of the adaptive capacity of both potential projects and policy.

The rationale behind FoRWaRD is to identify a range of options and to provide the 'best fit' to prevailing social, political and economic circumstances. The decision support model provides a dual modular approach to the assessment of the risks and opportunities associated with the different policy options of water-stressed states. The first module examines a snapshot of the current 'food economy' of a country from the perspective of average production (as well as the extremes in exceptionally good and bad years), import, consumption and relative reliance on global food markets. It then examines major trends in food production through shifts in annual production, agricultural sector employment, agricultural contribution to GDP and major imports of food staples. It also examines the major changes in national food consumption trends and the relative importance of food aid to the economy.

In parallel, a 'water economy' module looks firstly at the production of water in average, good and bad years, the structure of the overall consumption of water, as well as sectoral consumption, the relative 'import' of water from neighbouring countries in terms of transboundary receipts (and the legal and political regimes surrounding these receipts), and the 'export' of water to neighbouring countries. It then looks in detail at the financing of the 'water deficit' (in average, bad and good years), through examining the origin and cost of 'imported virtual water'. It subsequently assesses the relative cost of this virtual water to the total import bill.

The model then provides a longitudinal analysis of trends, which assesses supply augmentation trends, demand management trends, changes in relative abstractions by sector, trends in virtual water imports, the relative change in the 'cost' of the virtual water import bill and the nature of the 'water gap' over time – in particular, the main cause of the gap: rising consumption, declining supply, or a combination of the two.

The third step in the model is the development of scenarios, through a combination of the outcomes of the two modules. This creates a picture of the projected trends as currently constituted in a 'status quo scenario'. It then posits three scenarios based on:

- increasing internal food production and the reallocation of water to allow greater efficiency and the augmentation of supplies to agriculture;
- the external procurement approach that involves increasing the external procurement of (virtual) water; and
- a 'combined' scenario where greater resources are devoted to agriculture as well as to the procurement of water on world markets.

The scenarios are then weighted against a number of factors, including the assessment of political risk, climatic risk and capacity. The assessment of capacity will consider the existence of sufficient levels of adaptive capacity to enable the implementation of policy based on the scenarios. Following these assessments, the time and planning requirements of different scenarios will be assessed, against which implications for assistance by external agencies can be measured (for example, budget support versus technical capacity-building; or technical assistance versus support for greater regional integration).

Lastly, and as a defining goal, the weighting of options against a set of poverty reduction criteria will help to establish the tradeoffs involved in finding the 'best fit' for the macroeconomic criteria against those that provide the greatest added value to poverty reduction goals (for example, in seeking to achieve the Millennium Development Goals).

The idea would be that the model is as simple as presented in appendix A, with drop-down tables and charts under each category and links between, for example, annual food production and abstractions of water by sector, and between virtual water imports and employed labour force in agriculture. The linking of categories would enable policy makers and others to visualise relationships that are often not clearly visible. This in itself would assist in creating greater transparency in decision-making and, in so doing, assist in increasing the scope of political 'feasibility'. A simulation of a possible scenario is presented in appendix B. This simulation aims to illustrate the tradeoffs in the SADC region between the development of a system of 'grain corridors' from the humid countries in the north of the region to the markets of the dry southern countries as opposed to the construction of water transfer infrastructure.

One of the more difficult tasks of the model – and for policy makers in general – is to link the 'big' issue of water supply to agriculture, hydropower and major policy questions of water supply and demand management to the 'small' issues of local, domestic and 'household'-level livelihood supplies of water. This is certainly beyond the immediate scope of the model, but it can provide some guidance on supplies, for example, to the livestock sector and the relative weight of livelihood needs within the wider consumption of water by the economy.

In order to explore the value of this further, it is necessary to unpack the concept of scale, of which there are two critical elements. The first relates to scale as a problem, whereas the second relates to scale as a solution.

Scale as a problem relates directly to the concept of complexity that has been noted above. In a hydropolitical sense, complexity adds yet another scale dimension to the core problem that needs to be managed by water-stressed states. This is now better understood than before, providing the opportunity to consider, by way of conclusion, scale as a solution. Water scarcity is a condition that is strongly linked to scale. While there may be an acute scarcity of water at catchment level – a condition that characterises all of the states in this particular study – there is no water scarcity at global level. This element of scale can be thought of as the classic paradigm of watersheds versus problemsheds (Earle 2003). It is in this paradigm that trade in virtual water becomes an important element of the solution in managing water scarcity in water-stressed states. Such trade in virtual water has a number of advantages, the most notable being the politically silent nature of the remedy that it provides, combined with the fact that

it is ecologically sustainable and usually provided at significantly subsidised rates (Allan 1998; 2000a).

Conclusion

This study has shown that the core problem that confronts water-stressed states is that of complexity, which manifests as risk and uncertainty. Associated with this is the propensity for a non-linear increase in the demand for ingenuity driven by the increase in complexity over time. The fact is that water-stressed states are often associated with an outflow of competent people, manifesting therefore as a non-linear decrease in the supply of ingenuity over time. The combination of these factors is uncertainty. The key policy challenge therefore relates to the capacity of water-stressed states to make decisions about extremely complex issues under conditions of extreme uncertainty. One of the elements of a viable remedy is the development of a decision support tool, with elements of this having been isolated in this study. The FoRWaRD model is nothing more than a concept at this stage, with at best a crude set of criteria having been isolated. This is offered as an output of this project in the hope that it will stimulate the further development of such a decision support tool in the future.

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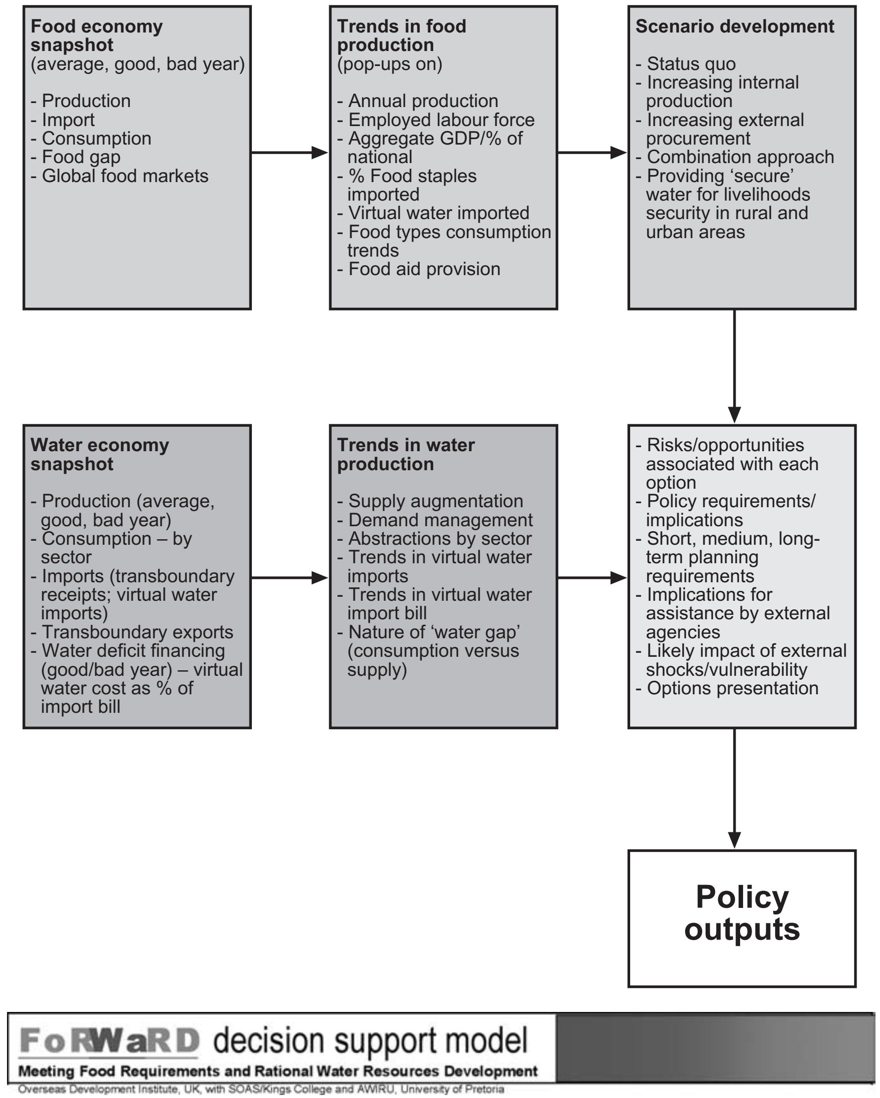
APPENDIX A
Decision support model



Appendix B
Decision support model application: Scenario examples

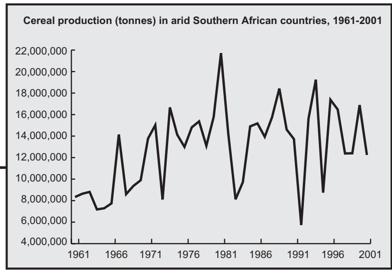
The following example illustrates how FoRWaRD can aid the policy formulation process with regard to the tradeoffs involved between increased interbasin transfers and greater reliance on food imports. The grain trade and production figures are taken from FAO (1961-2000; 2003b) and the water resource figures from FAO (2003a) and Shikhlamanov (1999). The example looks at the arid Southern African states and their grain production and trade balance.

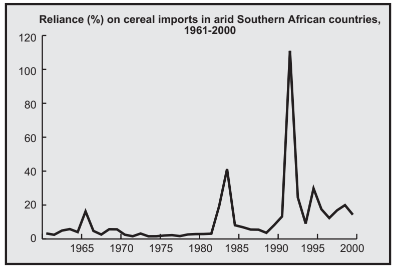
Food economy
(tonnes of cereals)

Average
Production = 13,712,522
Imports = 3,195,892
Consumption = 15,086,484
Reliance = 21%

Good
Production = 19,240,031
Imports = 2,214,970
Consumption =16,273,460
Reliance = 9%

Bad
Production = 5,727,368
Imports = 7,136,943
Consumption = 12,157,908
Reliance = 111%





Trends in food production

- Annual production shows little growth over the next decade – see pop-up chart.
- An increased reliance on virtual water imports is probable.
- Agriculture contributes a smaller fraction to the regional economies.

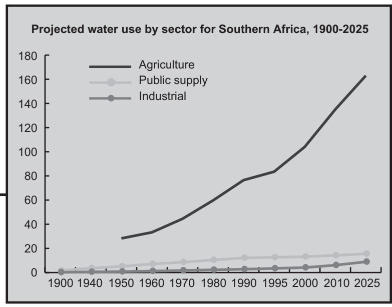
Scenario development I

1. **Increased local agricultural production** will require water transfers from the 'humid' Southern African countries, eg the Congo and Zambezi rivers. Capital as well as O&M costs of these schemes are high, with unpredictable environmental and social consequences.
- The increase in water imports if all grains are to be grown locally can range between 2-7 km^3/y if no more use is made of local supplies. Estimated cost: $400-$1,400 million (based on the capital and O&M costs of the LHWP).
2. **External procurement of grain crops** – if 50 % of all grain is imported into the region roughly 7 km^3/y of water will be made available locally.
- Cost would be about $840 million (at CIF price of $120/t).
3. **A combination approach** would blend the above two options – embark on a low level of water transfers for use in agriculture, as well as importing more grains.
- This would maintain agriculture's contribution to GDP by encouraging more crop per drop, while allowing industry the water needed for development.

Water & food module combination & development of scenarios

Water economy

- Locally produced water = 76 km^3/y
- Consumption = 17.5 km^3/y
- Agriculture = 76%
- Domestic = 15%
- Industrial = 9%
- Water imports: 17.4 km^3/y
- Cereal virtual water imports:
  Average = 3.2 km^3/y
  Good = 2.2 km^3/y
  Bad = 7.1 km^3/y
- Transboundary exports = 24 km^3/y
- Virtual water cost @ US $0.15/m^3:
  Average = $480 million
  Good = $330 million
  Bad = $1,065 million



Trends in water production

- If past trends continue agriculture will remain the dominant water consumer – see pop-up chart.
- Demand management coupled with the effects of HIV/Aids has seen a lowering of projected consumption figures for most of the region.
- The steady increase in the reliance on imports has resulted in greater quantities of virtual water imports over the past decade.
- In 'good' years local water supplies are adequate, but the high variability of rainfall necessitates a greater reliance on grain imports.

Scenario development II

1. The first scenario would encourage local grain production. This would stimulate rural development and make a contribution to the economy. However, it would prove difficult to recoup the costs of the water transfer through the production and export of grains, as world market prices are low. Drought years could still pose a threat.
2. The second scenario points towards a strong water demand management approach within the region. Industrial development would be favoured over grain production. The need for water transfers will decrease due to the 'extra' local water available for industrial and domestic use. The money saved could be invested in improving the transport infrastructure of the humid countries to enable them to produce the grain. The policy would only be viable if industrial development empowers people to be able to buy imported grain. The region would be susceptible to shocks from the international markets.
3. A combination of the two presents a good mix of rural and industrial development. The agricultural sector would use water more efficiently and in return be granted water at a reasonable price.

Policy outputs

FoRWaRD decision support model
Meeting Food Requirements and Rational Water Resources Development
Overseas Development Institute, UK, with SOAS/Kings College and AWIRU, University of Pretoria