CHAPTER 4

Looking Ahead: Drivers, Scenarios, and Responses

4.1 Drivers of Change in Ecosystems and their Services

We need a solid grasp of the various driving forces, or *drivers*, that operate in the system to understand current trends in supply and demand of ecosystem services, the consequences for ecosystems and human well-being, and to be able to contemplate the directions these trends might take in the future. In the context of the Millennium Assessment, a driver is any natural or human-induced factor that directly or indirectly causes a change in ecosystem services. There is a distinction between direct and indirect drivers. A direct driver unequivocally influences ecosystem processes and can therefore be identified and measured to differing degrees of accuracy. An indirect driver operates more diffusely, often by altering one or more direct drivers. Its influence is established by understanding its effect on direct drivers (Millennium Assessment 2003). These are also referred to as primary and proximate drivers, and are often used to describe situations in which a human intent (primary driver) is linked with physical actions (proximate driver) (Millennium Assessment 2003).

In Chapter 2, we discussed drivers of change in the specific ecosystem services. Many direct drivers such as land-use and impoundment are traceable to another set of indirect drivers that create the conditions for them to happen. For example, population growth in the Gariep basin is an indirect driver of change in ecosystem services (Figure 4.1). Little growth occurred up until 1800, with expansion starting in the 19th century with the arrival of Europeans and continuing at a steady pace during the 20th century. This in turn spurred the industrial expansion in the region that began in the mid-1900s and catalysed a wave of dam construction and other developments (*see Box 4.1*).

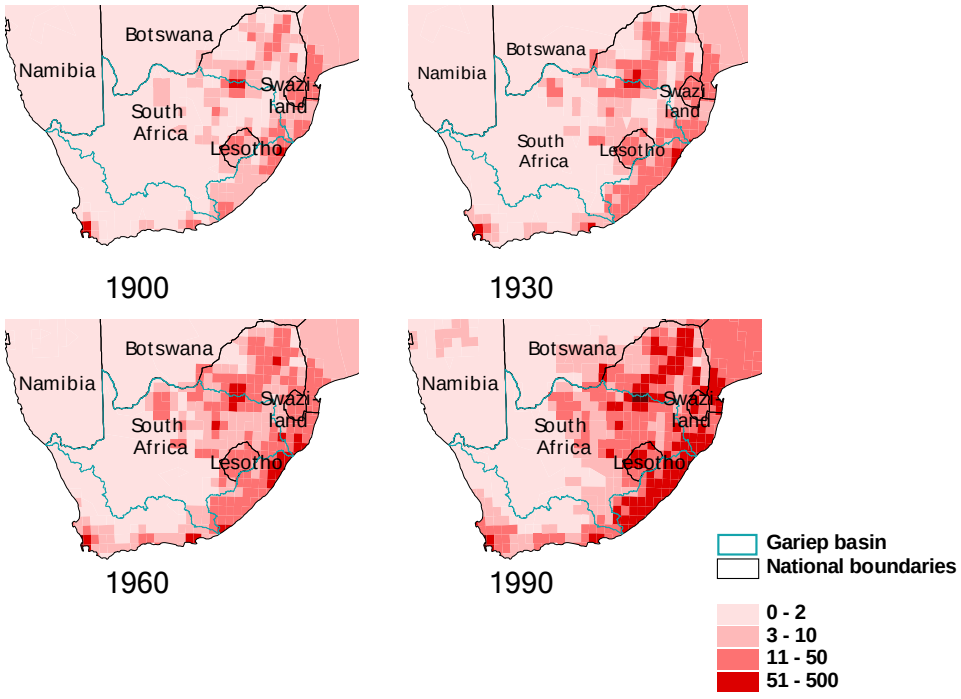

Figure 4.1 Indirect driver: Demographic change in the Gariep basin. Estimated historical population density of the basin and surrounding regions, 1900 – 1990. *Source:* Klein Goldewijk (2001).

We identified six categories of indirect drivers in the Gariep basin (Table 4.1): 1) governance change, 2) demographic change, 3) economic change, 4) climate change, 5) social/cultural change and 6) large-scale interventions on behalf of government, the private sector, or other relevant institutions. There are, of course, numerous examples of ways in which these drivers defy categorization as indirect or direct; every driver that is identified can be traced back a step in the

chain of causality to another driver. Climate change, for example, may operate as a direct driver that is a product of one or more indirect drivers. Governance, economic or social/cultural change can cause demographic change. Furthermore, a consensus on driver identification can be difficult to achieve due to differences in perspectives about system dynamics, no single one of which is "correct". In consultation with the Gariep Basin User Advisory Group, we chose to focus on the direct and indirect drivers we see as being the most descriptive of pertinent changes in ecosystem services and human well-being.

Such an exercise of driver identification must consider the role of scale − both spatial and temporal. A change in ecosystem services observed at the basin scale may be attributable to a shift in national government policy. Other factors may drive change at the local scale, while change might not even occur at all. The Gariep local assessments identified a different set of drivers, some of which are consistent with the basin-scale drivers and some of which are not relevant to the basin. These were divided further into generic drivers that operate in all of the local assessments as well as specific drivers at each of the local-scale sites (Table 4.2).

Furthermore, drivers may interact; for example, when a new leadership takes power that passes novel trade regulations, or when economic change occurs after a change in governance. On the other hand, economic change may result from climate change, where warmer temperatures precipitate the collapse of an important agricultural sector. The interaction of drivers over space and time can either exacerbate or cancel out the effects that each would be expected to have when considered in isolation.

Box 4.1 Direct Drivers: A Timeline of Transformation of Gariep Basin Rivers

1800s: Korana people farm on Gariep River banks; Europeans build first irrigation scheme at Upington
1872: First dam constructed in Gariep basin
1880: Gold discovered in Johannesburg; water demands of the region begin to increase
1912: Passage of South Africa's Irrigation and Conservation of Water Act lays foundation for future water allocation; reserves surplus water for private property owners, and establishes irrigation boards
1928: Department of Irrigation conceives idea of Orange River Development Project, but considered too costly
1943: Annual flow of Gariep River reaches 62-year high of 25,472 million cubic metres†
1950s: First survey of water resources of Basutoland (now Lesotho) undertaken to assess viability of water exportation to South Africa
1956: South Africa passes Water Act no. 54 to accommodate needs of industrial expansion
1962-3: Political climate enables Orange River Development Project to win approval; poor planning results in delays and a quadrupling of initial budget
1971: Gariep Dam completed; storage capacity (5341 million cubic metres) equal to roughly one-third of Gariep basin's total runoff
1975: Orange-Fish Tunnel begins to deliver water from Gariep River to Eastern Cape Province
1978: Vanderkloof Dam completed, the highest (108 metres) in South Africa
1986: Treaty signed to implement Lesotho Highlands Water Project (LHWP) after 8 years of negotiations
1992: Annual flow of Gariep River reaches 62-year low of 818 million cubic metres†
1995: Katse Dam – at 185 metres, the highest in Africa - completed in Lesotho's Maloti Mountains
1998: South Africa's Water Act no. 36 declares water a human and environmental right; first LHWP water is released

Sources: Chutter *et al*. 1996, World Commission on Dams 2000, Thompson *et al*. 2001, DWAF 2002b, Metsi Consultants 2003, DWAF 2003a.

†Based on annual flow records from 1935-1997; mean flow for period was 6980 million cubic metres.

Table 4.1 Indirect (primary) drivers of change in the Gariep basin.

Driver	Explanation	Mechanisms of change in ecosystem services and human well-being
1. Governance Change	Change in the structure, role or effectiveness of national, regional, and local government and its consequences for devolution of authority to sub-national bodies, participation of citizens, access to information, transparency, conflict resolution, checks and balances, and environmental management. Also entails change in the role of private sector rather than government in provisioning public goods, security, and regulation.	The way in which rules and laws are made and enforced affects the supply of, management of, or access to ecosystem services and human well-being. For example, when a government (or private investor) builds better roads, there is improved access to markets and hence an adoption of more sustainable agricultural practices, and improved access to and quality of education and healthcare.
2. Demographic Change	Change in size and structure of the population, such as population size and rate of change over time (birth and death rates), age and gender structure of a population, household distribution by size and composition, spatial distribution (urban versus rural and by country and ecosystem), migration patterns, and level of educational attainment, prevalence of HIV/AIDS.	Demographic change may entail an increase in population, which decreases the per capita availability of food, fuel, water, and a wide range of ecosystem services. Demographic change also drives changes in greenhouse gas emissions, and hence human-induced climate change. When coupled with growing income and other factors such as urbanisation and market development, population growth increases the demand for food and energy, with negative consequences for ecosystems and human well-being.
3. Economic Change	Change in global economic growth and its distribution by country, sector, community and individual, which in turn may be caused by international trade, capital flows, technology and political change.	The growth rates of an economy and employment frequently result in a higher demand for services, although as incomes rise a shift may be observed from locally produced to imported products. The degree of inequality in the ownership of resources, trade and capital flows, and subsidies and taxes also impact on change in demand and consumption of ecosystem services, land use patterns, resource extraction, water diversion and pollution, biodiversity losses, changes in greenhouse gas emissions and hence human-induced climate change.
4. Climate Change	Regional increase in temperature and associated changes in precipitation, increasing aridification, increases in extreme weather events such as heat waves, floods, and droughts and associated fires and pest outbreaks.	Changes in temperature and precipitation can directly, or indirectly, by changing land cover and land-use, result in shifts in supply and quality of ecosystem services due to altered flow regimes and crop production, biodiversity loss, and increased invasive species introductions.
5. Social and Cultural Change	Change in values, beliefs, outlooks or desires of a (usually substantially large or influential) segment of society; change in lifestyles.	Social and cultural change affects attitudes towards, perceptions and use of ecosystem services and links to human well-being; it may also affect attitudes that result from other drivers, such as economic change, which in turn cause changes in the ways ecosystem services are used.
6. Large-scale Interventions	Once-off (and typically, infrequent but influential) actions by government or private sector that lead to large shifts in land cover and land-use.	These “surprise” interventions can change supply of, management of, or access to ecosystem services, with implications for human well-being. These include the authorization of large dam construction, irrigation schemes, protected areas, and land tenure policies.

Table 4.2 Generic local-scale drivers, common to the three sites, but with varying degrees of change.

Generic drivers	Description of trend
Demographic change	Low change: skewed population consisting of old and young people; small increase in total population size High change: large rural depopulation; skewed population consisting of old and young people; economically active population reduced
Large scale interventions	High-handed: interventions that have no benefit to local people and take useful land and resources away forcefully Community-friendly interventions: local capacity building and fair benefit flows
Macro-economic change	Real positive growth: (4-5 percent) with reduced Gini coefficients/inequality ratios No economic growth Negative growth / economic contraction
Policies	Reasonable policies are implemented. Reasonable policies are not implemented or poorly implemented with no or little external and government support. Policies are abused.
Value system change	High materialism: People become more materialistic, and strive towards short-term, material benefits rather than longer-term intangible benefits Limited materialism: Some individuals or groups emerge that advocate for longer-term benefits and a less materialistic approach
Infrastructural change	Infrastructural growth: Infrastructure such as telephone connections, electricity, reticulated water, and condition of roads gradually increases. Access to services improves. Infrastructural stagnation/decline
Climate and weather patterns	It becomes warmer and drier.

Table 4.3 Local-scale drivers that are specific to each site.

Richtersveld	Sehlabathebe	Great Fish River
Local level institutional change	International donor priorities and sentiments	Availability of water through the transfer schemes
Agreements and infrastructure	Governance: traditional vs. conventional values	Credibility and legitimacy of leadership
Water availability from the Gariep	Lawlessness e.g. stock theft	Access to key resource areas or patches
Access to key resource areas	Irrigation schemes	Exceptionally high levels of HIV/AIDS
Transfrontier park		

4.2 The Gariep Basin in 2030: Envisioning the Future with Scenarios

Scenarios are plausible visions of alternative pathways to the future, and the consequences for various aspects of life on earth. Scenarios differ from forecasts, projections and predictions, all of which relate more closely to the "probable" rather than the "possible" (Peterson *et al*. 2003). *Scenario planning* is a useful, structured way to stimulate thinking and debate about future events or trends, and to make explicit our uncertainty about these. It can be particularly informative when dealing with complexity in a system like the Gariep basin, in which numerous biophysical, socioeconomic, political, and cultural factors interact in ways that are not well understood or easily controlled.

The Gariep basin scenario planning exercise aimed at gaining insight into the uncertainties and potential surprises that may affect the basin, its ecosystems and their services, and the well-being of its inhabitants to the year 2030, given different outcomes for the future. To construct a meaningful set of scenarios for this region, we first explored the wealth of existing scenarios previously produced for the region. Many of these involved several years of research and workshops with a broad spectrum of society. We also investigated the feasibility of adapting elements of the global scenarios being developed by the Millennium Assessment to the Gariep basin.

After reviewing these two bodies of scenarios literature, we chose to pursue development of a unique set of scenarios for the basin, with input from the Gariep Basin User Advisory Group (UAG) as well as the SAfMA teams working at the regional and local scales.

Overview of Scenario Planning for the Region

The objectives of scenario planning may be varied. Building consensus and stimulating dialogue are among the main reasons for using scenarios, as was the case with the Mont Fleur Scenarios, perhaps the most influential of scenario planning exercises in the region (*see Box 4.2*). In other situations, where the need exists to analyse quantitatively future trends, the purpose may be to develop tools to create scenarios and thereby enable projections.

Box 4.2 What will South Africa be like in 2002?

This was the question asked by the Mont Fleur Scenarios, developed in the early 1990s to explore possible outcomes of South Africa's transition to democracy. These scenarios posed four alternative futures in which majority rule takes hold with varying degrees of success and sets the country on a new political and socioeconomic course:

- *Ostrich* – No settlement reached and minority rule continues.
- *Lame Duck* – Transition slow and indecisive.
- *Icarus* – Transition rapid, but new government pursues unsustainable policies.
- *Flight of the Flamingos* – New government adopts sustainable, democratic policies.

This undertaking was considered a remarkable achievement on several counts: it illuminated the potential opportunities and pitfalls at stake, focused public attention on previously unfamiliar issues, and engendered an interdisciplinary network of politicians, businesspeople, academics and others interacting around a common challenge, of which perceptions were broadened or even changed.

Source: Kahane 1992. A follow-up set of scenarios entitled "South Africa 2014: Boom or bust?" has been published (Mail & Guardian 2003).

Scenario exercises and tools developed to address issues in the region are generally of two types: qualitative integrated approaches that focus on socioeconomic and political change, such as those completed at Mont Fleur, and quantitative sectoral efforts. The former type follows the Shell/SRI International model of scenarios based on the qualitative integration of political, economic and

social elements of possible future worlds (Peterson *et al*. 2003). Typically, the latter type is designed around a particular issue, such as the environmental effects of the Lesotho Highlands Water Project, or future projections for achieving specified goals, such as meeting water requirements. In both instances, these are typically developed at the national rather than basin scale.

We reviewed a number of scenario exercises[1] but found that, in most cases, they would have limited applicability for our purposes. Those of the political nature did not describe implications for ecosystems, and those that were more sector-specific, while useful for pursuing questions relating to specific services, or analysing trade-offs, did not allow for the integration of the full range of ecosystem services, human well-being and their drivers of change. The global Millennium Ecosystem Assessment scenarios, on the other hand, are capable of such integration, but their applicability to the dynamics occurring at the scale of the Gariep basin was uncertain, and required an attempt at translation.

Scaling Down the Future: From Globe to Basin

A number of global scenario archetypes have been identified based on clusters of driving forces, such as economic and geopolitical forces, and social issues (Gallopín 2002). Four of these archetypes were adopted for the global MA scenarios: *Market Forces* and *Policy Reform* see a continuation of current processes and forces. *Fortress World* and *Local Learning* describe a world driven by a global economy, but an unmanageable one in which poverty climbs and institutions collapse. *Value Change* marks a significant shift in values, with an emphasis on sustainability and community. Table 4.4 gives a classification of the global MA scenarios, and scenarios in development in three SAfMA studies.

Table 4.4 Classification of the MA global scenarios, the SAfMA regional scenarios, the Gariep basin scenarios, and the Gariep local assessment scenarios into five scenario archetypes.

Scenario archetype	MA Global scenarios	SAfMA regional scenarios	Gariep basin scenarios (this study)	Gariep local assessment scenarios
Fortress World	Order from Strength		Fortress World	
Local Resources	Adapting Mosaic	African Patchwork	Local Learning	Stagnation
Market Forces	Global Orchestration Technogarden		Market Forces	Green Engineering
Policy Reform		African Partnership	Policy Reform	Betterment
Value change	Rosy			

[1] In addition to Kahane (1992), these included Tucker and Scott (1992), the Foresight scenarios of the Department of Arts, Culture, Science and Technology (now DST) (DACST 1996), Metsi Consultants (2002) and Schlemmer (2002).

These archetypes were interpreted for the Gariep basin to explore their potential applicability to the region during the next 30 years. Our analysis was limited to four scenarios. We discarded the fifth archetype, *Value Change*, because we considered it unlikely for the Gariep basin during the next 30-year period, and therefore not especially informative.

Table 4.5 Bifurcations of key uncertainties and their demographic consequences under four scenarios: FW = Fortress World; LL = Local Learning; MF = Market Forces; PR = Policy Reform; √√ = exceptional, √ = good; X = poor or non-existent; L = low, M = medium, H = high.

Key Uncertainty						**Demographic Consequence**			
	Political, Economic and Social Environment					**Population**			HIV/ AIDS Mgmt
	National Govern-ance	Local Govern-ance	National Economic Growth	Distribution of Wealth	National Social/ Environ-mental Policy	Births	Deaths	Urbanisa-tion	
FW	X	X	X	X	X	H	H	Increasing	X
LL	X	√	X	√	X	M	H	Constant	X
MF	√	X	√	X	X	M	M	Increasing	√
PR	√	√	√	√	√	L	L	Increasing	√√

Scenarios tend to be most effective if designed to address a few key uncertainties. We chose to develop scenarios for the Gariep basin around bifurcations, or branches, of several important, yet uncertain, elements (Table 4.5): the strength and effectiveness of national government, the strength and effectiveness of local government, national economic growth, wealth distribution, and national social and environmental policy. These have unique implications for demographic trends (i.e. birth rate, death rate, and urbanisation) and management of HIV/AIDS, which we define as one or more of the following: a cure for HIV/AIDS, widespread, equitable provision of treatment, and improved care for those living with HIV/AIDS and their dependents (*see Box 4.3*).

Box 4.3 What Role for Climate Change and HIV/AIDS in an Uncertain Future?

Two key uncertainties in the Gariep basin revolve around climate change and HIV/AIDS. What is certain is that by 2030, these two forces will have already changed life in the basin in perhaps significant ways.

Between 1990 and 2050 climate change is expected to raise temperatures by 2 to 5 ˚C, and decrease precipitation in the basin, which may threaten food production, water supplies, and biodiversity – although certain crops and species may thrive in some regions (IPCC 2001). For this exercise, we assume that current trends in climate change will continue during the 30-year period, and that due to lag effects these will not differ drastically between the four scenarios. However, the management of the impacts of current climate change, as well as of human activities likely to lead to future climate change, will differ between scenarios. Under *Policy Reform*, legislation governing activities that contribute to greenhouse gas emissions will be strictly enforced by national, provincial, and local governments. Under *Market Forces*, incentives will exist in some sectors to reduce emissions and more businesses will adopt environmentally friendly practices in general, but this will not occur on a broad scale, and legislation will be slow to materialize. Under *Fortress World* and *Local Learning*, the weakening of central government and the economy will have mixed results: industrial activity will decline, but will be highly unregulated, and measures to curtail greenhouse gas emissions will not be adopted.

HIV/AIDS afflicted approximately 26 percent of South Africa's population (DOH 2003) and 31 percent of Lesotho's in 2001 (UNAIDS and WHO 2002). It has been suggested that HIV/AIDS will reduce the South African adult population by in excess of 2 million by the year 2030 (Goldblatt *et al*. 2002). This has implications for demographics, the economy, ecosystem services, and human well-being, perhaps the most notable of which will be a loss of human capital, diversion of government resources, and increasing dependency burdens. One of the questions demanding attention in this regard relates to the stage the epidemic has to reach for it to exhaust the capacity of a society to continue functioning. The ability to keep producing food, for example, is not necessarily degraded when its producers are infected but is devastated when they develop full-blown HIV/AIDS (Harvey 2003).

Demographics influenced by HIV/AIDS are not likely to differ greatly between scenarios, but the consequences of that change for ecosystem services in human well-being will diverge. For example, we would expect to see differences under the four scenarios in the administration of treatment, of care for those with HIV/AIDS and their dependants, and in the ability of government institutions (and food producers) to meet more specific and often greater demands for ecosystem services, such as adequate water and food. Furthermore, the capacity for preventing future HIV/AIDS transmission will also differ under the scenarios. We have implied that HIV/AIDS management will be poor in a *Fortress World* or under *Local Learning*, as the national government will play a limited role in providing the necessary framework and resources to deal with the disease. However, the role of international agencies in helping to curtail the transmission of HIV/AIDS and administer treatment to existing patients under these scenarios should not be overlooked.

4.3 Scenario Storylines

In what follows, we present the four scenario storylines and their consequences for ecosystem services and human well-being.

Fortress World

Key Features of the Fortress World

Drivers
- Collapse of national governance
- Economic collapse
- Weak civil society

Ecosystem Services
- Illegal, unregulated exploitation
- Widespread degradation
- Ineffective service delivery
- Some sources of pollution decline, but are highly unregulated

Human Well-being
- Elites live in security enclaves, depend on imports
- Poor become increasingly impoverished

Following the collapse of governance in 2014, long predicted by some, South Africa sinks into a state of political turmoil and economic decline, reminiscent of the situation that began more than a decade earlier in neighbouring Zimbabwe. This has a negative impact on ecosystems throughout the Gariep basin and the well-being of the entire population, driving many with the means to emigrate from the region. The elites who stay – which include corrupt government officials, exploitative multi-national concerns and warlords – manage to survive in security enclaves and are frequently dependent on imported commodities. The poor majority has no voice in government and is forced to be self-reliant in an impoverished and hostile landscape. There is a notable absence of civil society networks in this disrupted society.

This compromises the ability of the rural poor to survive against a variable and arid climatic regime, and many seek employment in cities. The illegal and unregulated exploitation of minerals by corrupt officials and warlords provides sufficient income to prop up dysfunctional regimes. There is no effective service delivery to the majority of the population; ecosystem services are degraded and unsustainably exploited. There is also no effective enforcement of protected area legislation, and the poor resort to poaching and harvesting of resources in reserves. One positive upshot for ecosystem integrity and human well-being is that the reduction in industrial activity decreases associated air and water pollution. Most gains are offset by the government's failure to extend electricity and water services to people who instead put increasing pressure on the limited biofuels and water supplies they can access.

Ecosystem services in urban areas suffer the most. Here there are sharp declines in the quantity and quality of water, energy, food, biodiversity, and air quality shared among its 12 million residents, many of whom are unemployed and undernourished. Mineral extraction, financed by private and foreign investors, increases. The welfare of the elites takes a downward turn, though slight in comparison to the steep decline of that of the poor population, which lacks the resources and options of the wealthy.

Population declines in rural regions have some surprising consequences for ecosystem services. In the Great Fish River, for example, air quality improves slightly due to the reduction in manufacturing that occurs here in the wake of economic decline. However, as in the urban areas, there is a differential decrease in the human well-being of the elites who are somewhat buffered from the changes in their surroundings, and the poor, who are not. The conditions of ecosystem services in the arid western part of the basin are compromised but less so here than in the other regions because of its tradition of self-reliance.

However, only modest levels of mineral exploitation are profitable, and in the absence of beneficiation and community mining projects, local benefits do not materialize. In the basin's commercial farming areas, once known as its "grain basket", food production suffers, as agricultural investments are designed to secure benefits for the wealthy few rather than the poor masses. With cutbacks in industry and energy production, particularly coal-burning, degradation of biodiversity and air quality continues only at slight levels. With no policies enforced to manage these services, they show no signs of improving. With the severe cuts in energy and food, the basin's poor suffer substantially, while the well-being of the elites is somewhat reduced.

While Lesotho's government remains stable, it is deeply wounded by events beyond its borders. In 2017, South Africa defaults on its royalty payments for the Lesotho Highlands Water Project, and many of the benefits once provided to Lesotho under this arrangement are eroded. Migrant workers seeking work in South African industries are increasingly turned away. The only hope is for positive political change, or an international intervention.

Local Learning

Key Features of Local Learning

Drivers
- Weak national governance
- Weak economy
- Strong civil society
- Community-driven land-use practices
- Strong reliance on informal sector

Ecosystem Services
- Poor service delivery
- Over-harvesting of resources
- Crop failures common
- Encroachment on protected areas

Human Well-being
- Increased mortalities from water-borne diseases and indoor pollution
- Conflict and violence caused by lack of access to resources

Ineffective national governance, corruption and economic mismanagement across most of the basin keep poor people impoverished. Low economic growth rates and declining foreign trade and investment exacerbate the economic marginalization of South Africa and Lesotho. However, strong civil society networks encourage local infrastructure development, with service provision dependent on community initiative.

The rural population, growing steadily and faced with a declining resource base for subsistence farming, becomes increasingly locally organized and self-reliant. The remnants of commercial agricultural are sufficient to feed the urban markets until 2030 but are expanded onto lands that are more marginal. This has devastating environmental consequences. Agricultural diversity provides some resistance to pest outbreaks though crop failures are common, as droughts occur more frequently due to climate change. The conditions for the urban poor deteriorate rapidly due to the absence of a resource base and a lack of service delivery. A declining and impoverished infrastructure isolates the rural poor. However, local tourism initiatives that emphasize conservation do spring up in places, and catch the eye of international NGOs who proceed to lend them support.

Most local authorities are unable to make the promises of the free basic water and electricity programs a reality, and mortalities from water-borne disease and indoor pollution increase. Poor environmental standards become prevalent, and waste products are dumped onto poor communities across the basin. This results in deteriorating water and air quality, increased soil erosion and untreated sewerage. Lack of access to water, land, and mining rights increasingly causes local tensions and conflict across the basin.

In the absence of a strong central government and market mechanisms, all regions look locally to obtain the services they need. Their welfare varies: while there is less ambitious development of resources, there are also lower levels of pollution, producing only moderate declines in water quantity and quality region-wide. The sparsely populated arid west manages to maintain its energy, food, and biodiversity at constant levels. Small declines in energy occur in all other regions. Food production drops drastically in the Great Fish River, where the effects of climate change, land degradation and a reduced labour force because of HIV/AIDS curb the capacity of the remaining arable land to feed its growing population.

In the urban centres, reduced economic activity means a slight, but not severe, deterioration in water, energy, food, biodiversity, and air quality, while the output of the minerals industry slowly increases, still fuelled by foreign investment. For its affluent inhabitants, life is slightly worse; it is much worse for the poor. The arid west elites maintain their well-being at constant rates, while the poor in this region are slightly worse-off. In the grain basket, many who rely on a now-reduced agricultural income experience a lower sense of well-being, regardless of their affluence. Lesotho, recognizing the need for economic independence from South Africa, embarks on a program to reform its agricultural productivity, but needs international assistance. The local discovery of a plant endemic to the Lesotho grasslands with high pharmaceutical value piques foreign interest in Lesotho. This calls attention to the need for more formal conservation of this biome, as well as stronger legislation to protect intellectual property rights.

Market Forces

Key Features of Market Forces

Drivers
- Strong economy facilitated by national governance framework
- Lack of wealth distribution
- Weak local governance
- Weak social and environmental policies

Ecosystem services
- Expansion of mining activities
- Increased development of water resources
- High levels of water and air pollution
- Erratic agricultural production
- "Development before conservation"

Human Well-being
- Inadequate health service delivery
- Decreased food security for poor
- Increased income disparity, though marginal benefits accrue to urban areas

Gauteng continues to expand as the industrial heartland of the basin. As rural living conditions deteriorate the rural poor flock to the rapidly expanding peri-urban areas to find employment. Water and air pollution caused by poorly regulated coal power generation and increased industrial effluent lead to a higher prevalence of water-borne diseases and infant mortality rates among the poor. Insufficient health service delivery compounds this and leads to a declining life expectancy for the poor across the basin. Mining activities expand across the area and are largely exploitative of the available human capital and the environment. The combination of mining, commercial agriculture, and cheap labour supports most visible economic activity. Income disparity increases. Due to a lack of emphasis on social services, no great strides are made in improving the well-being of the poor, but they do benefit marginally from the trickle-down effects of a growing economy, particularly in urban areas where most wealth is concentrated.

South Africa's entry into free trade agreements pushes agricultural production toward exports, such as grapes along the Gariep River, and results in a reduction of grain production in the basin. Meanwhile, the effects of climate change result in increased temperatures and variable rainfall, and the lack of a clear policy framework for climate change decreases household food security for subsistence farmers and the rural poor, especially in the arid west. Farming on increasingly marginal lands promotes soil erosion, and reduces water quality through siltation. Water is also increasingly impounded and diverted to be used by industry, urban and commercial agriculture. Poor enforcement of environmental legislation negatively affects biodiversity conservation. Societal values largely favour developmental initiatives over conservation concerns.

In the urban areas, an emphasis on economic growth stimulates production of food, energy, and minerals, but increased demands for water place pressure on limited resources. Economic and industrial growth, without policies to govern their environmental, social, or health implications, results in declining water quality, biodiversity, and air quality. Human well-being remains constant for elites and poor alike, due to the combined effects of increases in some services and reduction of others. The Great Fish River does not fare as well, and watches its entire ecosystem services decline due to an ineffective distribution of the social grants on which they depend. This results in a sharp decline in human well-being of the poor section of the population, and a slight reduction for the elites. The arid western region performs better: though it receives fewer of the benefits of national economic growth, the population's reliance on local ecosystem services is a buffer against the associated declines in biodiversity and air quality. Water is an exception, as upstream abstraction from an already-taxed water supply leaves less water of adequate quality for this region. The elites experience a slight improvement in their well-being, owing mainly to the continued investments in mineral resources. Due to its links to Gauteng, the grain basket mirrors somewhat its patterns of economic growth, but food production increases only slightly as the economic climate favours the services, manufacturing, and trade sectors over agriculture. Human well-being remains constant for both elite and poor members of the population. In Lesotho, environmental problems as a result of the water transfer scheme, notably siltation, begin to ignite conflict between residents and farmers who are affected, and champions of economic growth, who believe that extending the LHWP is crucial to development of Lesotho's economy. The number of migrant workers reaches an all-time high but the cumulative effects of HIV/AIDS during the past thirty years are severe.

Policy Reform

Key Features of Policy Reform

Drivers
- Effective democratic governance
- Strong, globally-linked economy in a balanced trade regime
- Significant poverty reduction
- Substantial investments in health, education, and ICT sectors

Ecosystem Services
- Intensification of agriculture
- Strengthening of protected areas
- Tariff system and catchment management encourage efficient use of water

Human Well-being
- Improved food security
- Improved access to water and energy

A strong commitment in South Africa and Lesotho to good governance and regional peace and security is finally emerging. The region attracts increased foreign investment and a fair trade environment promotes its global competitiveness. In the Gariep basin, this leads to responsible expansion of industrial investment together with socially and environmentally responsible governance. Improvements in infrastructure, health, education, and service delivery are supported by a vibrant technology sector.

Consequences of the new policies for ecosystem services are mixed. Intensified agricultural practices support high economic growth with the rapid adoption of genetically modified organisms (GMOs), irrigation, pesticides, and fertilizers in the basin. This meets with some resistance from small farmers unable to invest in these inputs and health and environmental advocates, yet organic farming practices are also on the rise. Overall, productivity is boosted, and the expansion of agriculture onto marginal land is prevented. Food security across the basin improves. Pressures on water supplies increase, but an effective system of water tariffs, together with the establishment of catchment management agencies now ensures that users are accountable for their abstractions. Cash crops are widely produced by commercial farmers who trade in a global economy but due to past biodiversity losses the genetic stock is impoverished. This marginalizes small growers except for those linked to designer markets, such as organic farmers. Climate change increases crop vulnerability to pests and diseases and droughts and floods occur more frequently. Intermittent food shortages occur, but do not threaten food security in the basin. Increased wealth drives agricultural production towards meat production. Intensive livestock production - batteries and feedlots, for example - becomes more common across the Gariep. A drive toward more intensive meat production leads to an expansion of game farming operations in the basin, and creates a link between protected areas. Reduced pressure for land means a more positive outlook for conservation in general. Biodiversity and environmental education are high on the agenda of policymakers, and the concept of ecosystem services becomes widely familiar.

A growing proportion of the energy needs of the urban and wealthy population in the basin are derived from alternative power sources (e.g. solar and nuclear) but coal still dominates as the most important source of energy production. Growing mining and industrial activities reduce water and air quality. Water purification costs increase and water scarcities south of the Zambezi become a potential source of regional conflict. However, the environmental legal framework is fundamentally sound and adequately enforced, enabling regional cooperation to mediate resource-related tensions.

The conditions of ecosystem services in the urban areas improve slightly, with the exception of biodiversity, in which exceptional recovery from past degradation is not observed during the 30-year period, but further declines are slight rather than steep. The already good level of well-being of elites increases slightly, while the poor benefit more significantly under policies with the equitable distribution of services such as water, electricity, and health care at their core. The Great Fish River also experiences improved access to most services, particularly energy, but air quality continues to decline due to lag effects of new policies to curb pollution. The positive effects of the new policy shifts are less dramatic in the arid western regions, where water quantity only remains constant. Large investments in energy seen elsewhere in the basin do not occur in this sparsely populated area, but access improves slightly as the national grid is extended and more solar power projects come online in the Northern Cape. Biodiversity and air quality remain constant, and exploitation of minerals increases steeply. Well-being improves slightly for both elites and poor. In the grain basket, reforms of the agriculture sector, including support for organic farming, results in

improvements in all services except biodiversity, still recovering from many decades of severe impacts.

Lesotho becomes a hot tourism destination, owing in part to the great success of the Drakensberg-Maloti Transfrontier Conservation Area and foreign investment in infrastructure. Yet the pressures from the rapid influx in tourist numbers challenge the capacity of park managers, while some local residents feel that they do not benefit from these conservation initiatives.

Scenarios across Scales: A Sensitivity Analysis

One of the challenges in scenario development regards the treatment of exogenous conditions and their potential influence on the scenarios. The problem of defining the bounds of the "fortress" in a *Fortress World* illustrates this well. At the global scale, the fortress separates powerful, well-off nations or regions from destitute ones. By this definition, South Africa and Lesotho are, to a large degree, outside the fortress. At the basin scale, the fortress separates members of the basin population. The question this raises is whether a *Fortress World* in the basin implies that the whole globe is also a *Fortress World*, or whether an alternative scenario might be conducive to a basin *Fortress World*. A second challenge we acknowledge is that a single, simplified scenario is unable to describe the whole suite of dynamics occurring at any scale, which instead is characterised by a combination of different elements of many different scenarios.

The effects of global and regional drivers of change, their interactions, and the strength of their impact on ecosystem services in the basin is highly dependent on the connectedness of the basin to the region or globe and its resilience to change in exogenous forces. This connectedness, and hence resilience, seems to vary between scenarios. We expect, for example, that if a *Market Forces* scenario dominates the global economy, a basin-scale *Fortress World* would be highly exploitable by external forces, increasing the vulnerability of governance, the economy, and society. The population would be likely to increase and urbanise, with little regard for ecosystem capacity to provide services, and ultimately generating negative feedbacks at a higher level and perpetuating the *Fortress World* situation. Conversely, if a *Policy Reform* scenario takes global prevalence, international pressure may mount to take punitive measures against the basin states that are not practicing good governance and an externally led effort to reform a *Fortress World* in the basin states might be possible.

Because of the convergence between scenarios at the SAfMA regional, basin, and local scales, we can explore these challenges by examining the sensitivity of scenarios at the basin scale to alternative combinations of scenarios occurring at both the broader and finer scales. Examples of how the two scenarios that correspond roughly to the *Local Learning* scenario - the *African Patchwork* scenario at the SAfMA regional scale and the *Stagnation* scenario at the local scale – might affect the basin are shown in Box 4.4.

This comparison of scenarios highlights the cross-scale nature of political and environmental security. It will be difficult to achieve *long-term* security in the basin, for example, while there are high levels of instability at the regional scale or massive poverty at the local community scale. Despite this, interpretation of the *African Patchwork* scenario for the Gariep basin indicates that at the national scale, some level of disconnectedness from other nations is desirable, as heavy dependence on external resources increases a nation's vulnerability to changes in the stability of its neighbours. The *Stagnation* scenario, however, suggests that highly impoverished communities are dependent on external resources in the form of government support, and have little recourse to escape poverty without intervention. A key difference is that the *Local Learning* basin-scale scenario assumes that civil society networks will function independently of the central government and that these will play an essential role in accessing ecosystem services and improving human well-being. If this is true, the *Local Learning* scenario for the basin perhaps overestimates the ability of local communities to devise innovative solutions to benefit from ecosystem services in the absence of any institutional or financial support. *Local Learning* also does not consider the importance of the acceptance of interventions by communities in order for these to succeed.

In addition to enabling the identification of linkages between scales, comparing scenarios at different scales can provide a first-cut reality check on storylines and identify features that may need more development.

Box 4.4 Scenarios Across Scales

Zooming out: African Patchwork in the SAfMA region

Key drivers:

- Governance: Weak, ineffective states in most countries – but democracy and good governance take hold in some countries; regional fragmentation; ongoing localised military conflicts drain resources, damage infrastructure and impede the provision of services; little investment in health and education
- Economy: Low economic growth rates and declining foreign investment lead to the increased economic marginalization of Africa; informal sector dominates

At the regional scale, the Gariep might be one of the more successful "patches" in the *African Patchwork*, perhaps surrounded by less successful ones. This would result in high levels of immigration to the Gariep basin states from other nations. Heightened competition for water would be a particular problem. If the Gariep itself is "patchy," with South Africa being a more successful patch and Lesotho an unsuccessful one, the basin's water supply could be endangered; however, this could motivate South Africa to lend support to Lesotho and thus rebuild the nation.

We could also hypothesise a situation in which South Africa, succumbing to a *Fortress World* scenario, becomes one of the more unstable nations in the patchwork, while neighbouring Lesotho, Namibia, and Botswana all become more stable and achieve increased economic growth. Under this scenario, many rural South Africans (commercial and subsistence farmers and those in the tourism and mineral industries) may try to move their operations elsewhere. With climate change making conditions in the arid west increasingly inhospitable for farming and unattractive to tourists, Lesotho, Zimbabwe, and Mozambique may appear more favourable for relocation. Gauteng's numbers might decline, with urbanites re-establishing themselves in other African cities, and many others fleeing further afield.

The implications of such a patchwork are firstly that in an unstable political climate, states will have to be much more independent in order to survive. This may lead to better management of some shared services, such as water, in the realization that the instability of other SADC nations will continue to inhibit regional sharing or cooperative production of services for some time. Secondly, countries that succeed in this environment will be confronted with a growing number of unemployed and asylum-seeking individuals from beyond their borders. This will place increasing pressure on those countries' resources and conflict is likely to emerge even in relatively stable, peaceful societies.

Zooming in: Stagnation in Rural Communities

Key Drivers:

- Governance: Democracy prevails, but policies are not implemented; large-scale interventions are implemented in a heavy-handed manner
- Economy: Negative or zero economic growth; there are no prospects of employment; human lives and values in the cities are cheap and people migrate back to rural areas.

At the community scale, much depends on the extent to which national economic growth and policy implementation trickles down to the local level, especially in the more isolated rural areas. This scenario illustrates a situation in which this does not happen, and any investment in communities comes merely as a by-product of outside interventions, typically designed to reward benefactors. These interventions may yield no benefit to the communities at all, and sometimes are simply destructive, undermining community structures.

Rural communities are increasingly impoverished throughout the Gariep basin, leading to rapid deterioration of ecosystem services and human well-being, with people managing to survive off resources of a more marginal quality than ever before but pushing many ecosystems beyond a reversible threshold. The notion of a "protected area" rings hollow in this environment, as the desperation of the neighbouring communities drives them to encroach unabashedly on these areas. While social capital in the form of bonds and networks between community members is important, the prevailing levels of poverty and lack of options keep birth rates very high, seeming to dictate the fate of successive generations. Ultimately, when a crisis arises, bonds break down, and the conflict that emerges is of significant proportions to affect stability on a broader scale, which finally alerts those at a higher level of power.

Negligence on the part of national governments will saddle them with an enormous burden in the decades to come, even when economic growth picks up and action taken to uplift their people from poverty. Many more will need to be uplifted, while fewer ecosystem services will be available with which to sustain them.

We conclude the scenarios analysis by stressing that this is a first attempt to introduce the concept of scenario planning in the context of ecosystem services and human well-being in the Gariep basin, and to stimulate thinking about possible futures. These scenarios should not be treated as predictions for the future of the Gariep basin. They are simply an exploration of the consequences for the future of the basin's ecosystem services and human well-being given certain conditions. As such, a statement of the relative likelihood of these futures cannot be made here.

Certain elements of these scenarios describe the situation in the Gariep basin today. The more developed parts of the basin represent a *Market Forces* world with an active economy but limited distribution of wealth. The *Local Learning* scenario is generally applicable in the more rural areas of the basin where traditional authority still prevails and service delivery is relatively poor. The division of elites and poor, indicative of a *Fortress World,* is evident in the wealthier parts of the basin, although this has not been accompanied by a collapse of national governance and the economy. Finally, the *Policy Reform* scenario shows signs of emergence in certain sectors where economic and social policy interventions are beginning to succeed.

Thus, a careful look at the basin now, combined with a reflection on its history and an understanding of drivers of change across multiple scales, are likely to serve as the best preparation for what may come. In future iterations, a set of scenarios could also consider the types of responses that would be likely to take place and how they might feed back on key processes.

4.4. Response Options in Alternative Futures

As the examples discussed throughout this report illustrate, many responses involve a combination of typologies. Interventions designed to manage the state of an ecosystem often are part of a broader policy measure, or are closely linked to educational and outreach efforts, for example. In most cases, a course of action will be needed that includes several types of responses that complement each other and serve multiple objectives. A response with very specific or short-term goals is not as likely to succeed because it ignores the complex web of relationships between different aspects of the ecosystem or populations. In the past, technological responses have often been constructed and implemented in this way, with unintended and often negative consequences emerging later.

Responses that address policy and institutions, responses directed at improving ecosystems and their capacity to deliver services, and responses that emphasize education are usually key ingredients in successful ecosystem and resource management. Technology and economic instruments often play an important role, but may not be successful in the long term unless embedded in a larger program of sustainability. Technological responses in particular have a dangerous ability to mask problems - and to disregard their root causes - rather than solve them (Berkes *et al.* 2000). However, technological responses can demonstrate great success when they improve human well-being in the short term, and decrease the dependency of people on any particular component of ecosystems by simultaneously increasing their options over the long term.

At the same time, few of the types of responses mentioned can be implemented in isolation. Policy and institutional measures that are not socially acceptable or economically favourable do not guarantee success, nor do interventions to improve the state of ecosystems and service provision that fail to distribute their benefits equitably, or responses that improve education but do not empower people to act on it.

The nature of the response adopted in a given situation will depend in part on the respondent's perception of the situation, which will depend on values, objectives, and available information, but also on his or her capacity to act. This capacity will vary between individuals and organizations, and will be influenced by existing circumstances. It can be helpful to explore this issue under a set of alternative scenarios such as those sketched in this report.

Feasibility of Responses under Alternative Scenarios

Which types of responses will be feasible given the adaptive capacity of ecological, social and management systems? We have to think about the political, economic, and social context in which responses will be shaped and executed. In Table 4.6 we indicate which responses are most likely to be adopted under the assumptions of our four scenarios. Under *Policy Reform* we assume a higher capacity to utilise multiple responses, including legal and policy responses, than under other scenarios. However, some additional considerations need to be borne in mind. As revealed by the cross-scale comparison of scenarios discussed earlier, the level of regional stability will limit the adoption and success of responses in the Gariep basin. In addition, responses at the basin scale must recognize the importance of and variation in local-scale conditions that will likewise enable or constrain adoption and success. The significance of scale in choosing among responses cannot be overemphasized. Too often, responses suffer from a scale mismatch – spatial or temporal (Redman and Kinzig 2003). The outcome of a response made under these conditions is that it often has unintended effects.

Box 4.5 Local Responses to Ecosystem Change

People at the three local assessment sites cope with ecosystem change through strategies to reduce their risk. They become seasonally and spatially mobile and flexible, and invest in landscape diversity rather than monoculture. They also diversify the household labour force, and invest in formal education. People also scale down, by reducing herd sizes and field sizes.

People may try to forecast the future, but in this, they are less successful than in planning their day-to-day activities. They may rely on rumours or superstition to forecast but their desire to predict is high. People also form local institutions to help them deal with uncertainty. They fall back on traditional customs and rules, but also form new cooperatives such as burial societies, savings clubs, and self-help groups. Religion plays a more important role in their lives than before, and may be a mix of Christianity and African Traditional Religion. People also gather often frequently for oral communication.

Another strategy is to adapt management practices. People try new enterprises such as eco-tourism, and increase their off-farm incomes. They also explore new technology, such as water tanks, ploughs, and mechanized pumps. As a response to shortages, people broaden and extend their definitions of food, fertilizer, and fuel. They reduce overheads drastically, and tend to spend all their efforts on food security and basic needs.

Rural households and communities interact with and respond to their surrounding environment in innumerable different ways depending upon the ecological, social, and economic contexts prevailing at any given time. They are both reactive to unanticipated circumstances, as well as proactive in optimizing opportunities and minimizing risks to sustainable livelihoods. Coping strategies and adaptation common to the three sites include:

- A diversity of livelihood strategies
- Temporal flexibility in the livelihood portfolio
- Internal stratification
- Links to urban centres
- Multiple landscapes and environments; multiple resources and species from each environment
- Resource and species substitution
- Secure water resources
- Mobility
- Nurturing social and kin networks

Table 4.6 Which responses in which future?

Scenario	Types of responses likely to be adopted
Fortress World	Economic; limited technological (but only benefit elites)
Local Learning	Social, behavioural, and cognitive responses, etc. (but locally organised)
Market Forces	Technological; economic (legal, institutional to lesser degree)
Policy Reform	Management of resource/ecosystem; legal, institutional, policy responses; knowledge and education (technological to lesser degree)