CHAPTER 5

Adding it up: A Synthesis

5.1 The Big Picture

By providing services, ecosystems underpin and sustain the livelihoods of human beings, societies and economies. The links between ecosystem services and human well-being are complex, as the harnessing of services does not always benefit people, and sometimes has detrimental effects. This assessment resolved to examine these relationships by using measures of demand and supply. However, while a demand and supply approach may be able to identify some of the physical barriers to deriving benefits from ecosystems; it does not consistently capture the actual impediments to service delivery. Many situations exist in which supplies of a service are adequate, but human-well being demands remain unsatisfied. This is particularly true in a region such as the Gariep basin with a history of inequality.

We suggest that a useful synthesis of condition and trends of ecosystems and human well-being in the Gariep basin entails an examination, more specifically, of: 1) the ability of services to meet human well-being requirements, including the capacity of ecosystems to continue producing services, and 2) ecosystem service "hotspots" that either are key areas of service production, produce an irreplaceable (unique) service, or may be sources or locations of conflict or potential conflict in the near future.

Table 5.1 depicts four components of the ability of provisioning ecosystem services to fulfil the basic requirements for human well-being: adequate supplies, effective distribution, associated health impacts, and the capacity of ecosystems to continue providing the service. In some cases, it is indeed a shortage of the service that results in its failure to satisfy minimum human well-being requirements, for instance, when demand for fuelwood (perhaps because of population growth) outstrips the capacity of existing resources. In other cases, a service is not provided because distribution channels are ineffective or non-existent. Still in others, benefits from the service come at a cost to human welfare. This is illustrated by mineral services: while mining provides an ecosystem service of value to some members of the population by generating revenue and providing jobs, it involves processes that generate widespread negative effects on human health that, at least for some, outweigh its benefits. Pesticides used to improve the efficiency of food production may be harmful to humans and livestock, as may water works that alter natural ecosystem characteristics. Lastly, unsustainable use of ecosystem services can compromise the capacity of the ecosystem to continue to provide services, threatening the well-being of future generations.

The wealth of relationships between ecosystems and human well-being extends beyond the provisioning services. As a regulating service, good air quality is vital to health. As noted in Table 5.1, inappropriate energy policies that create externalities are a cause of decreasing air quality, and unacceptable levels of air quality present a threat to health. Preservation of cultural services is essential to good social relations, and where such services also have a utilitarian value, may also be essential to achieving the material minimum for well-being. Cultural services may also be important to health, security, and freedom and choice. In some cases, of course, ecosystem services may be replaceable or substitutable; that is, alternative options exist to meet a specific need. While water and air have no true substitute, food and energy come in different forms, and switching between them is often a crucial human well-being survival strategy.

Figures 5.1a – h depict ecosystem service and human well-being "hotspots," which include: irreplaceable areas for food production (able to supply caloric and protein requirements) and biodiversity, areas in which water requirements are approaching available surface water supply, areas in which groundwater is high in salinity, municipalities in which one quarter or fewer of households have access to electricity from a local authority, municipalities with significant mining activity, and a synthesis map of several key services. Each service has a unique spatial pattern. The eastern and north-eastern regions of the basin, for example, are highly irreplaceable for the provision of food, while the eastern and south-eastern regions produce high levels of surface water runoff.

Table 5.1 Ability of provisioning services to meet human well-being requirements.

	Food	Water	Energy Services	Mineral Services
Adequate supplies?	Basin can supply 50 percent more dietary energy and three times more dietary protein than needed.	Limits of current supply may be reached by 2025; climate change could exacerbate scarcity.	Fuelwood becoming increasingly scarce; coal supplies adequate for long-term (300 years). Investment in other energy sources and technologies remains limited.	Supplies abundant, but exploitation depends on economic viability.
Effective distribution?	Social inequality and disparity in income distribution make some sources of protein and energy unaffordable.	Free basic water to be granted to all but infrastructure is lacking. Some 5 million people still obtain water from rivers and springs and 16 million lack sanitation; others cannot afford to pay for additional water.	About 70 percent of South Africa electrified; 50 percent in rural areas; three percent of Lesotho. Connections remain unaffordable to many residents; environmental and social externalities not reflected in costs.	Largest benefits rarely accrue to those who bear the cost of mining's externalities.
Implications for health?	Source of water and air pollution. Uses superfluous amounts of water, causes land degradation. Fertilizers, pesticides, GMOs may have negative effects on health.	Pollutants in untreated water lead to potentially lethal water-borne diseases; infrastructure alters natural characteristics of water bodies and their regulating processes.	Coal-burning produces high carbon dioxide and sulphur dioxide emissions, affecting air quality; contributes to greenhouse gas emissions.	By-products of mining affect air and water quality; extraction creates excessive ecological disturbance, which interferes with ecosystem function and biodiversity.
Capacity of ecosystems to continue producing service?	Will require technological inputs to improve production; land degradation and climate change pose potential problems.	Will require implementation of resource protection measures and ecological reserve.	High capacity to produce coal and renewable sources; supply of fuelwood will depend on sustainable management.	High capacity for 30-year timeline.

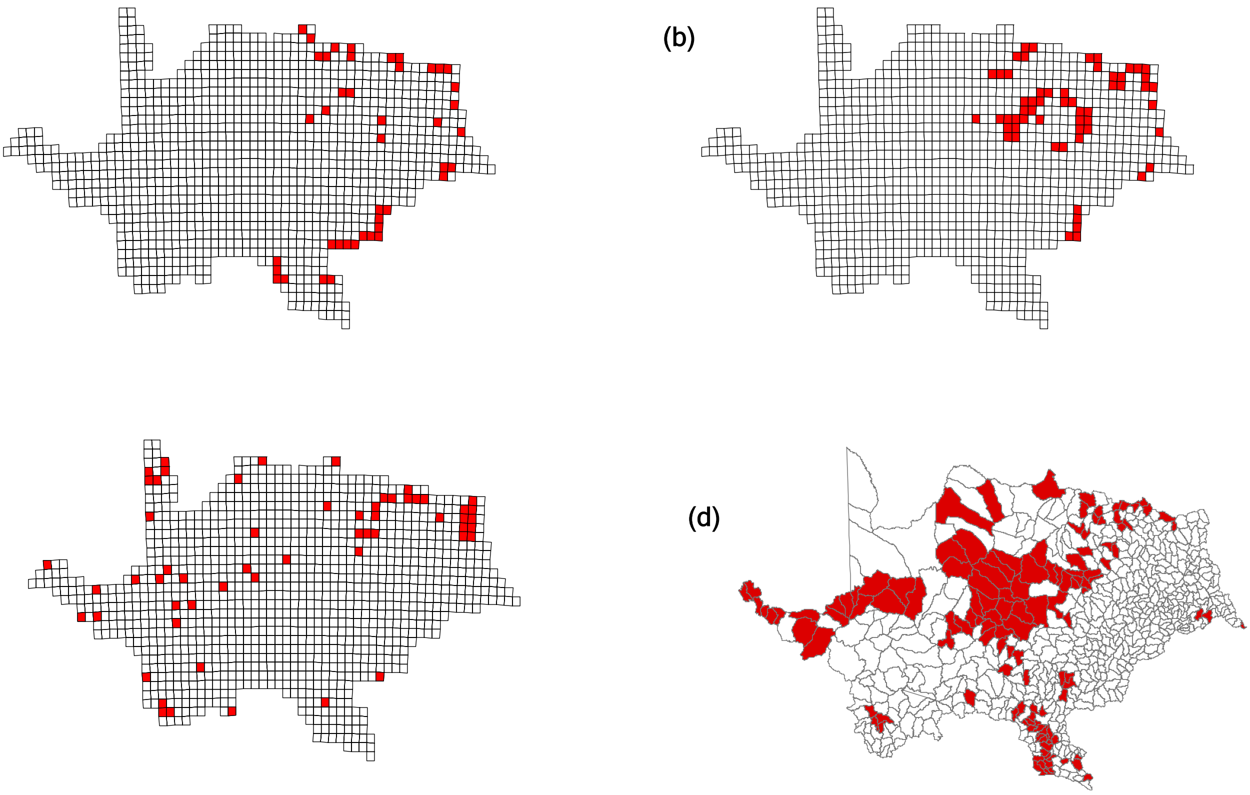
These regions also largely coincide with areas of high biodiversity value, and in some cases with areas with high water stress, mines, and poor air quality. These regions must therefore be planned for carefully in order to deliver ecosystem services without compromising ecosystem integrity. The high levels of agriculture and urbanisation are well-known concerns in the basin and have impacted on the ecological integrity of this region already (Fairbanks *et al.* 2000, Reyers *et al.* 2000) with most of the indigenous grasslands of the region under severe threat.

In addition, the arid western region of the basin could be a potential area of conflict. This is important to highlight, as it is not an area that receives a lot of attention in land use and biodiversity planning initiatives (with the exception of the Succulent Karoo). This area is a source of mineral wealth and contains several irreplaceable biodiversity sites due to the concentration of many endemic species. However, it is also vulnerable to water scarcity, surface and groundwater quality problems, and desertification, all of which may be amplified by climate change. The region is further hampered by its low level of development, exemplified by the low percentage of households connected to the electricity grid who must obtain energy from other sources. On the other hand, it is less vulnerable to threats associated with high levels of development. The coincidence of these features suggests that if this area is not well managed, the implications for biodiversity, ecosystem services, and human well-being in the area could be severe.

Key resource areas: hotspots at the local level

The community assessments revealed that the patchy distribution of ecosystem services enables local people to cope with and benefit from ecosystems in environments that, from a distance, appear extremely hostile. In the Great Fish River, people walk up to three kilometres to obtain fuelwood and construction materials in particular landscapes, known for their ability to provide these goods. These landscapes are often abandoned when they are over-harvested, to be revisited several years later once they have recovered. Inaccessible, distant, or policed areas serve as refugia for genetic stocks of highly preferred fuelwood and kraalwood species such as *Ptaeroxylon obliquum* (sneezewood) and *Olea europeae* var *africana* (wild olive). Certain medicinal plant products such as the bark of slow-growing trees are confined to the interiors of large forests, where they are protected by taboos that permit only ordained herbalists or healers to access them. Animal resources such as honey and wildlife are also restricted to the most remote and dense forest and woodland patches, where only the most skilful hunters can find them. Fountains and streams represent key resource areas for water security during times of crisis, for example when government authorities fail to maintain water infrastructure.

(a) (b) (c) (d)



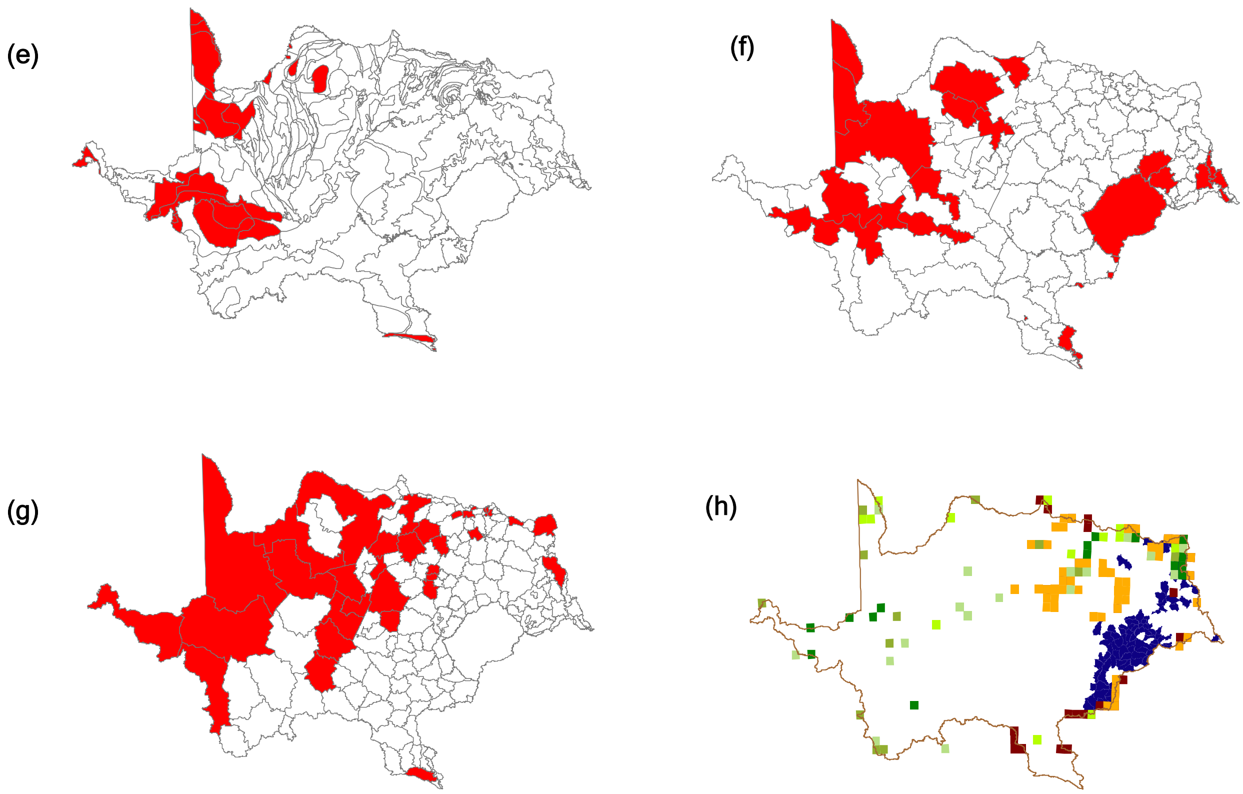


Figure 5.1 Ecosystem service and human well-being "hotspots:" Areas of the Gariep basin with high levels of service provision, unique services, or in which service provision or human well-being may be of concern. (a) Grid cells with irreplaceability values of more than 0.5 illustrating areas of importance to the provision of upper targets of protein, (b) calories, and (c) biodiversity conservation; (d) Quaternary catchments in which surface water requirements are 60 percent or more of availability; (e) Geohydrological units in which groundwater salinity (TDS) is above 2400mg/l; (f) Municipalities in which electricity is supplied by a local authority to 25 percent or fewer of households, and (g) with 2 or more producing mines or exploited deposits. (h) Synthesis map of key ecosystem service areas in Gariep basin for surface water (blue), cereal production (orange), protein production (brown), and biodiversity features with high irreplaceability (green; intensity of colour increases with irreplaceability value).

These water sources depend on the maintenance of even smaller critical areas such as wetlands and sacred pools. At an even finer resolution, individual plants, especially trees, are mapped in social memory as key collection points for honey, fruit, bark, or walking sticks, or for their spiritual value during critical times such as traditional ceremonies.

In the Richtersveld, the Gariep floodplain is a key resource area for fodder, shade, and water for people and livestock during the hot dry summer months. The Gariep also acts as a key source of drinking water all year round, and people use it to complement their protein by fishing or hunting for bushmeat. The Gariep floodplain is also a key resource area for tourism and mining, and is therefore a highly contested area with claims made by all the main stakeholders. Further inland, fountains and wells are hotspots for the survival of pastoralists, while minute quartzite outcrops are biodiversity hotspots for endemic succulents, but are also used by people and animals to escape the mid-day heat because they are slightly cooler than the surrounding landscape. In Sehlabathebe, small forest patches represent key resource areas for water and fuelwood, and small pockets of deeper soils in sheltered areas are reserved for vegetable production.

The overlap of areas with high levels of ecosystem services or areas of concern does not imply conflict, but the management of such areas will require an integrated, multiple-use approach in which different stakeholders are represented. True "hotspots" may exist where technical, institutional, or ideological barriers constrain the implementation of such an approach.

Implications for Decision-Making

Clearly, a number of response options exist to improve the benefit streams from ecosystem services to human societies without undermining ecosystem integrity. The political and social changes now occurring in southern Africa have far-reaching consequences for the way ecosystem services and human well-being are managed in the future; it is thus imperative to develop an increased understanding of the opportunities and constraints that are faced in choosing and implementing responses. The experience gained in this assessment indicates that the responses most likely to succeed in problems related to ecosystem services and human well-being will:

1) *Recognise complexity.* Ecosystem services and the people who depend on them comprise complex social-ecological systems. Narrow, single-issue or single-sector perspectives are likely to promote unwanted consequences in other sectors. Responses that take all relevant sectors into account when planning for any particular sector are more likely to avoid unexpected surprises, and are better prepared for those surprises when they come.

2) *Be implemented at the appropriate scale.* The scale of a response must match the scale of the process; often, a multi-scale response will be most effective. In particular, tenure systems, institutional arrangements, and the role of privatisation have important implications for the continued provision of ecosystem services. That said, there are no “silver bullet” tenure arrangements for managing ecosystem services, and each situation demands a unique, scale-appropriate response based on the knowledge of and consultation with stakeholders.

3) *Strive to create synergies.* Where trade-offs must be made, decision-makers must consider and make explicit the consequences of all options. Tools such as those described in this report can assist decision-makers in visualising, understanding, and communicating the issues at stake.

4) *Enable natural feedbacks.* The ability of ecosystems to continue providing ecosystem services depends on natural feedbacks that can be seriously compromised when they are dampened by inappropriate management, policies, and governance models. Perverse subsidies are among the most damaging of incentives that promote inappropriate behaviours, and their eradication is an urgent priority.

5) *Be made through an inclusive process.* Making information available and understandable to a wide range of affected stakeholders is key. Asymmetries in society give rise to asymmetries in information, education, and income availability. These are usually translated to asymmetric ecosystem service benefits, reduced adaptability, and responsiveness. Collectively these asymmetries increase the vulnerability of disenfranchised communities. However, benefits derived from ecosystem services are pervasive throughout society. The awareness of these benefits among different groups needs to be raised, and social and economic development need to incorporate these benefits.

6) *Acknowledge uncertainty and enhance adaptive capacity.* Given the complexity of social-ecological systems, it is seldom if ever possible to fully understand the structure or functioning of a system to be able to reliably predict the outcome of an intervention or response. In choosing responses, we must understand the limits to our knowledge, and we must expect the unexpected.

7) *Enhance the adaptive capacity* of managers and of ecosystems. Resilience is increased if managers have the capacity to learn from past responses and adapt accordingly. Resilience is also increased if the capacity of the ecosystem to deal with change is enhanced or maintained.

8) *Assess and re-assess* the feasibility of alternative responses. A change in one or more system drivers can lead to a previously unfeasible response becoming feasible, or vice versa. Care must be given to the prevailing social and cultural context in which a response is implemented, as this context also determines what is or is not feasible.

Decision-makers, whether they are ecosystem users, managers, or governments, must design responses that can meet the challenges noted in this assessment. Responses made in isolation are not likely to succeed, and coordination between those who choose and implement responses is needed across sectors and scales. This will require greater cross-communication between diverse actors, and the free flow of information between them. While our responses must acknowledge the limits to our knowledge about complex systems, we must strive to constantly improve upon it.

5.2 Epilogue: Lessons learned from a Multi-Scale Integrated Assessment Approach

One objective of this assessment was to determine whether such an exercise could actually be carried out, and whether the information and capacity to analyse it in the way proposed by the MA Conceptual Framework exist. In general, the Gariep basin is an information- and data-rich region of southern Africa. In particular, many South African and Lesotho government departments, NGOs, and industries have made large volumes of information freely available on the internet. This is promising, but major knowledge gaps remain, with the most obvious deficiencies relating to our understanding of ecological process and function, particularly the links between biodiversity pattern and process, and the relationships between ecology and hydrology. We are also plagued by the nearly universal difficulty of integrating the natural and social sciences, where great gains clearly stand to be made (Redman and Kinzig 2003). However, knowledge of ecosystems has evolved rapidly during recent decades, and will hopefully keep up the pace.

An important lesson learned from this process relates to the role of an assessment in plugging information gaps. Often at the conclusion of an assessment (and this one is no exception), as many new gaps are identified as old ones filled. While such a realisation may be frustrating, it can help to reframe questions and refocus research efforts so that they can address the most pressing concerns in light of these gaps.

Furthermore, there is inherent, and necessary, bias in assessments of this nature. Even an integrated assessment can only address a limited number of issues, a multiple-scale assessment can only include a limited number of levels, and most assessment designs can only accommodate a limited number of viewpoints, perspectives, and epistemologies. On balance, the larger SAfMA does span a reasonable breadth of issues, scales, and types of knowledge. Within the Gariep assessment itself, this “bridging” is done through the community studies, which reflect a rich body of local knowledge about ecosystems and their functioning.

5.3 Conclusion: Decisions for the Future

It is hoped that this assessment can provide guidance to decision-makers, by highlighting not only issues of ecosystem services and human well-being that deserve critical attention, but also the aspects of governance and management systems that can contribute to more resilient ecosystems and human well-being. Nothing may be more crucial to the sustainable management of ecosystem services than the free flow of information, and the enabling of individual as well as institutional flexibility, creativity, and innovation.

A more general but important achievement for this assessment process to strive for is to put the ecosystem services concept on the map. The significance of ecosystem services and their intimate relationship with human well-being is likely to increase in coming years and must be made tangible to a wider audience. Building capacity to understand, manage, and communicate the value of ecosystem services in the Gariep basin must target both new and established managers and scientists from all backgrounds to think in inter-disciplinary, multi-sectoral, multi-cultural, and cross-scale terms, so that effective decision-making can continue into the future.

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