



BAVIAANSKLOOF MEGA RESERVE STUDY

STATE-OF-RIVERS REPORT



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Introduction

The purpose of determining the health of rivers

Water gives life and provides various benefits to a range of users including, sustaining people, nurturing crops, recreation power generation, just to mention a few (DWAF, 2004). South Africa is considered to be a water-scarce country and therefore it is very important that water is used wisely and that water pollution is reduced and/or avoided (DWAF, 2004). This can be achieved through the implementation of appropriate integrated water resources management strategies with respect to the country's water resources. Integrated Water Resources Management (IWRM) can be defined as "A process which promotes the co-ordinated development and management of water, land and related resources in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" (DWAF, 2004). Freshwater resources are complex ecological systems consisting of various interlinked components which influence each other and also interact with elements from other systems such as human activity systems (agriculture, recreation, etc.). The complex inter-relationships between components of a system and the interaction with other systems need to be addressed by managers of water resources in a sustainable way (DWAF, 2004). For water resources managers to make informed decisions, they need access to accurate and up-to-date information on the health of the rivers and the impacts that surrounding (associated) human activity systems are having on them.

State-of-Rivers Reporting

State-of-Rivers (SoR) Reporting is undertaken to convey information gathered during the implementation of the River Health Programme (RHP) in such a way that it can be used by decision makers and managers. The main objectives of a SoR report are to (Strydom 2003):

- Supply relevant up-to-date water resources management information to government and other water resources management agencies
- Encourage and facilitate sound environmental decision-making;
- Inform the public regarding the state (health) of South Africa's water resources;
- Highlight the consequences of human activities on South Africa's water resources;
- Provide spatial and temporal benchmarks through continuous monitoring and reporting;
- Highlight problem areas and recommend management actions;
- Enable the auditing of the effectiveness of management strategies implemented.

The River Health Program

The National Water Act (Act 36 of 1998) requires that national water resources monitoring systems be established in order to collect data that will inform the sustainable management of South Africa's precious water resources (DWAF 2008). The River Health Programme (RHP) was initiated in 1994 in response to this requirement (RHP 2005). The RHP is a nationwide monitoring system that is focussed on assessing the health or integrity of aquatic ecosystems in South Africa. The RHP is based on the concept of biological integrity and makes use of biological indicators and indices (macroinvertebrates, fish and riparian vegetation) for assessing river health.



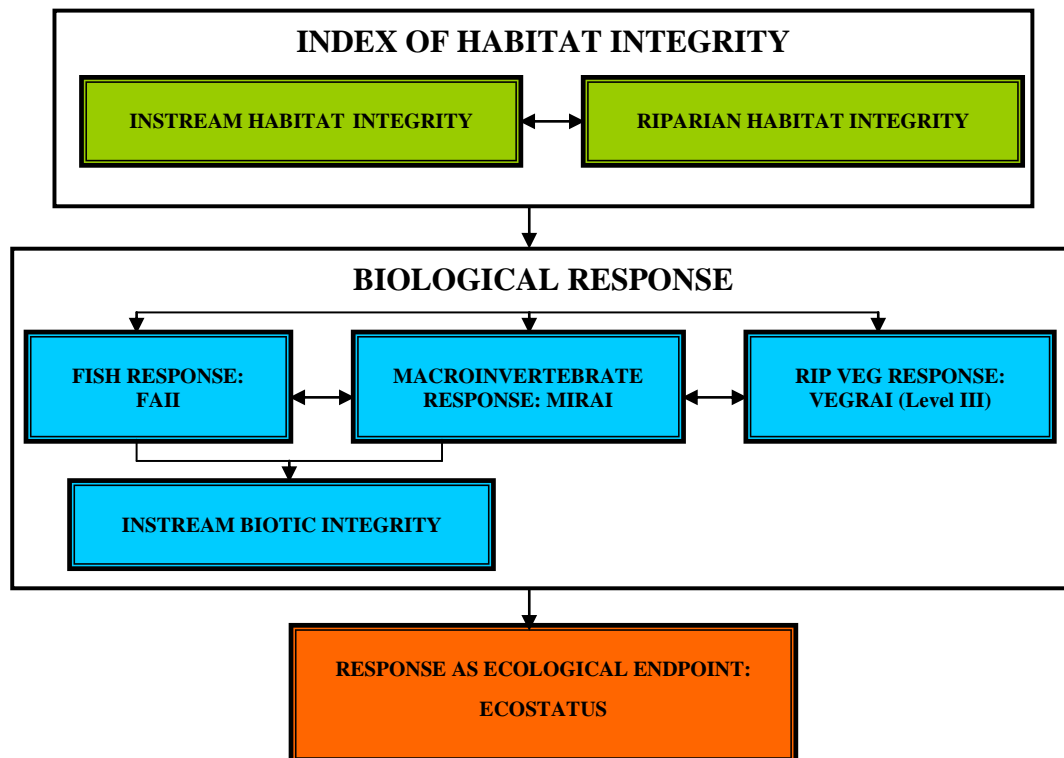
The national custodians of the RHP are the Department of Water Affairs and Forestry (DWAF), the Department of Environmental Affairs and Tourism (DEAT) and the Water Research Commission (WRC). The Programme is implemented by various levels of government including local (CMA), regional and provincial government. Collaboration is very important in the success of the Programme and therefore each province has a Provincial Task Team (PTT) which consists of a network of team members interacting on a regular basis (DWAF 2008).

EcoClassification

Ecological Classification, or more commonly known as EcoClassification, is the process used to determine and categorise the Present Ecological State (PES) of various biophysical attributes of rivers in relation to a natural or close to the natural reference condition. The information gained from this process can be used to derive desirable and attainable future ecological objectives for a river (Kleynhans and Louw 2007). The RHP also makes use of the EcoClassification process to analyse biological response data in order to determine the severity of biophysical changes. It focuses on the reference conditions and PES steps of the EcoClassification process (DWAF 2008).

Ecological status assessment (EcoStatus)

The health of a river can be expressed in terms of its biophysical components, namely the driver components and the biological response components. The driver components are hydrology; geomorphology and physico-chemical water quality which combined provide a particular habitat template for aquatic biota. The biological response components include aquatic invertebrates, fish and riparian vegetation. The ecological status of a river, known as its EcoStatus, represents the integrated state of the river by considering these driver and responses components (Kleynhans and Louw 2007).



EcoStatus indices

EcoStatus indices are numerical indices based one or more biophysical component to determine the condition (health) of a river. These indices provide the relevant (qualitative and/or quantitative) management information required by water resources managers to make informed decisions regarding issues that affect aquatic resources. The following indices are routinely implemented in the National RHP as well as EcoClassification and/or EcoStatus processes (DWA 2008):

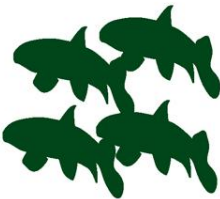
MIRAI



Macroinvertebrate Response Assessment Index

Aquatic macroinvertebrates are critical component of any aquatic ecosystem and are greatly dependent on the habitat template (water quality, biotope quality and availability, flow velocity and depth) in which they live. Their sensitivity to factors such as water quality, flow velocities, habitat quality and food availability makes them good indicators of the health of an aquatic ecosystem. Furthermore macro-invertebrates are relatively sessile and provide a good reflection of local impacts. MIRAI is based on the fact that aquatic macroinvertebrate assemblages reflect prevailing flow regimes, water quality and available habitat at a specific river site. MIRAI aims to provide a cause and effect foundation, based on the habitat template to interpret the deviation of the macroinvertebrate assemblages from the reference condition.

FRAI



Fish Response Assessment Index

Fish are one of the main biological components of aquatic ecosystems. Due to their relatively long lifespan and mobility, they can indicate long-term influences and general habitat conditions in a river reach. They represent a variety of trophic levels and therefore indicate the integrated effects of environmental changes (Murray, 1999). FRAI is a habitat-based, cause-and-effect index that interprets the deviation of an observed fish assemblage from the reference condition (expected fish assemblage) based on: i) Environmental intolerances and preferences of reference fish assemblages, and ii) Responses of constituent species to particular groups of environmental determinants or drivers. Intolerance and preference attributes of fishes are categorised into metric groups with constituent metrics that relate to the environmental requirements and preferences of individual species.

VEGRAI



Vegetation Response Assessment Index

A healthy riparian vegetation community is important as it maintains channel form and bank stability; regulates river flow and provides habitat for faunal species and corridors for their movement (Murray 1999). The aim of VEGRAI is to provide a rapid approach to assess changes in riparian vegetation condition. It does this by describing the status of the current riparian vegetation in relation to that of the reference state. The differences between the two states present a measure of vegetation response to an impact regime.

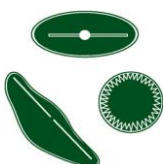
IHI



Index of Habitat Integrity

Habitat integrity of a river refers to the maintenance of a balanced composition of physico-chemical and habitat characteristics on a temporal and spatial scale that are comparable to the characteristics of natural habitats of the region. The Index of Habitat Integrity (IHI) is used to measure habitat integrity by considering the current condition of instream and riparian zones and interpreting their deviation from the reference condition. These deviations are determined by using an impact-based approach where the magnitude and degree of anthropogenic changes are used to interpret the impact on the habitat integrity of the system.

Diatoms



No index yet

Diatoms are considered to be good indicators of water quality because of their wide-spread occurrence, broad tolerance ranges, short generation times, sensitivity to changes in nutrient concentrations and rapid response to and recovery from eutrophication, to mention but a few. Diatoms are currently under consideration for inclusion in the RHP but a South African index for the RHP has not yet been developed.

Ecological Importance and Sensitivity (EIS)

Ecological importance of a river refers to its importance in the maintenance of ecological structure and functioning on local and wider scales. Ecological sensitivity indicates a system's ability to resist disturbance and its ability to recover from disturbance once it has occurred (DWAf 2008). The following EIS categories in Table 1 can be assigned to a river:

Table 1: Ecological Importance and Sensitivity categories and description [2]

EIS CATEGORY	DESCRIPTION
Very High	This indicates that there is a strong ecological motivation for awarding a high level of protection to the associated river and such rivers should ideally be maintained in a natural or good river health category.
High	
Moderate	This indicates a river that has a relatively lower conservation value and that such a catchment is more suited to development than one where a river has a higher EIS.
Low / Marginal	

Ecological categories

Ecological category provides a comparison between the present ecological conditions and the natural reference condition (Table 2). The A-F categories form a continuum in which the boundaries between the different categories are notional, artificially-defined points. When there is uncertainty as to which category an entity belongs it may belong to two classes and is then denoted as e.g. a B/C or C/D class (Kleynhans and Louw 2007).

Table 2: Ecological categories, associated meanings and colour codes used in RHP protocol

Ecological category	Designation	Description
A	Natural	Unmodified, natural.
B	Good	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.
C	Fair	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.
D	Poor	Large modifications. A large loss of natural habitat, biota and basic ecosystem functions has occurred.
E	Seriously modified	Serious modification. The large loss of natural habitat, biota and basic ecosystem functions is extensive.
F	Critically modified	Critically / Extremely modified. Modifications have reached critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and changes are irreversible.

Overview of the study area

Fish to Tsitsikamma Water Management Area

The Fish to Tsitsikamma Water Management Area (WMA) covers an area of 97 023 km² and consists of three large drainage basins namely the Great Fish, the Sundays and the Groot/Gamtoos. The primary drainage regions within this WMA are L, M, N, P and Q and a portion of Drainage Region K (DWAFF 2002). This SoR report addresses only the Groot, Gamtoos, Kouga, Baviaanskloof, Wit and Geelhoutbos rivers within drainage region L.

The catchment of the Groot River lies entirely in the Karoo and the river passes through narrow gorges in the Groot Winterhoek, Baviaanskloof, and Elandsberg mountain ranges before its confluence with the Kouga River. The Kouga River catchment arises in the Langkloof with its main tributary the Baviaanskloof River arising in the rugged mountains flanking the narrow Baviaanskloof Valley. The Groot and Kouga Rivers join to form the Gamtoos River which drains the western slopes of the Elandsberg mountain range and empties into the sea (DWAFF 2002).

Baviaanskloof Mega Reserve

Baviaanskloof means “Valley of Baboons” and is situated between the Baviaanskloof and Kouga mountain ranges in the western region of the Eastern Cape. The Baviaanskloof Mega Reserve area contains a cluster of formally protected areas including the Baviaanskloof Nature Reserve. This reserve is the third largest protected area in South Africa and was awarded World Heritage Site status in 2004 because due to its rich biodiversity. The Baviaanskloof Mega-Reserve Project came into being in 2002 and aims to conserve the area’s biodiversity, protect its critically important role of providing water for human and environmental use, and to promote sustainable economic development opportunities based on the natural assets of the area. It is envisioned that the mega-reserve will eventually cover around 500 000ha comprising a cluster of state-owned protected areas within a network of private and communal land. The private land owners that are included within the mega-reserve have to align their land-use activities with the principles and practices of biodiversity conservation (Boshoff 2005).



Physical characteristics

Climate

Rainfall is relatively evenly distributed throughout the year, with maximum rainfall normally recorded in March and November. The average annual rainfall for the Baviaanskloof mountain range is 451mm and 547mm for the Kouga mountain range. Frequent thunderstorms occur in the summer months and snow occurs annually on the higher mountain peaks in winter. The area is characterised by high daily and seasonal temperature fluctuations (ECPB 2007).

The prevailing wind direction in summer is south to southeast and northwest in winter. Dry berg winds can be experienced during autumn and the winter. Warm winds from the high plateau can cause temperatures of up to 44°C associated with relatively cool night temperatures (ECPB 2007).

The average daily maximum temperatures for the low-lying areas is approximately 32°C in January and 18°C in July with corresponding minimum temperatures of 15°C and 5°C respectively. Extreme fluctuations to between 5°C and -3°C have been recorded. Frost occurs from the beginning of June to the end of August (ECPB 2007).

Topography and geology

The area forms part of the Cape fold belt and is characterised by relatively high mountains. The average height of the Baviaanskloof, Groot, Winterhoek and Kouga mountains is more than 1200m above sea level. From the peaks, the slopes fall steeply to the north and south to end on a plateau level of 650 to 900m above sea level but the majority of the former land surface has been carved away by deep ravines to form valleys at an altitude of between 550m and 320m above sea level. These valleys include the Kouga, Baviaanskloof and Groot River Valleys (ECPB 2007). The geology of the area includes the five formations of the Table Mountain Group namely, the Peninsula, Cedarberg, Goudini, Skurweberg and Baviaanskloof formations. Sediments of the Enon formation are found in the valley in the middle of the area. The valleys also have large deposits of alluvial sand and gravel from the mountains and ravines that are transported by rivers (ECPB 2007).

Natural vegetation types

The Baviaanskloof area is an ecosystem hotspot containing seven different biomes, namely: Fynbos, Subtropical Thicket, Nama-karoo, Succulent Karoo, Grassland, Savanna and Forest. The Baviaanskloof Nature Reserve itself has more than 1100 species of plants with 20 of those known to be endemic. 52 species have also been listed as Red Data species. The dominant vegetation types are fynbos and subtropical thicket elements (ECPB, 2007).

Animal life

The Baviaanskloof Mega Reserve has a high animal diversity and high endemism. It has at least 58 mammal species including black rhino (*Diceros bicornis*) and leopards (*Panthera pardus*). The Baviaanskloof Nature Reserve has been recognised as a Globally Important Bird Area because of its more than 300 bird species which is more than a third of the total bird fauna of South Africa. 57 reptile species have been recorded, with almost half of these being endemic to South Africa. 15 species of indigenous fresh-water fish also occur within the reserve (Boshoff 2005).



Water Resources

The majority of the Baviaanskloof River catchment and a substantial part of the Kouga River catchment fall within the Baviaanskloof Nature Reserve. The water that flows from the Baviaanskloof Nature Reserve is of a high quality and is used for downstream agriculture and consumption by human communities. The Kouga Dam is located upstream of the confluence of the Kouga River with the Groot and Gamtoos Rivers and is fed by the Kouga and Baviaanskloof River catchments. It provides 100% of the water requirements of the Gamtoos River Valley irrigation area as well as approximately 30% of the requirements of the Nelson Mandela Metropole (Boshoff 2005).



Social and economic characteristics

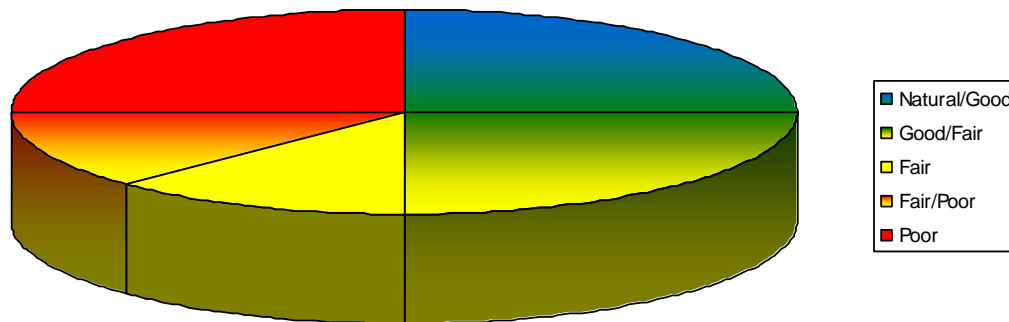
The Kouga River valley contains very fertile soil that is intensively cultivated mainly for deciduous fruit orchards. The Baviaanskloof River valley contains mainly unsuitable soils and therefore contains limited cultivated areas and these are mainly under pasture. The Gamtoos River starts where the Groot and the Kouga Rivers meet and an area of 56km² of land in the river valley downstream is irrigated from canals which carry water from Kouga Dam and Loerie Dam. The crops that are grown in this area include



vegetables, citrus, lucerne and tobacco (DWAf 2002). Within the Baviaanskloof Mega Reserve itself, agriculture, tourism and service industries form the basis of the area's economy. Because of the world heritage site designation, the future economic development of this area is based on the development of tourism (Baviaans Municipality 2008).

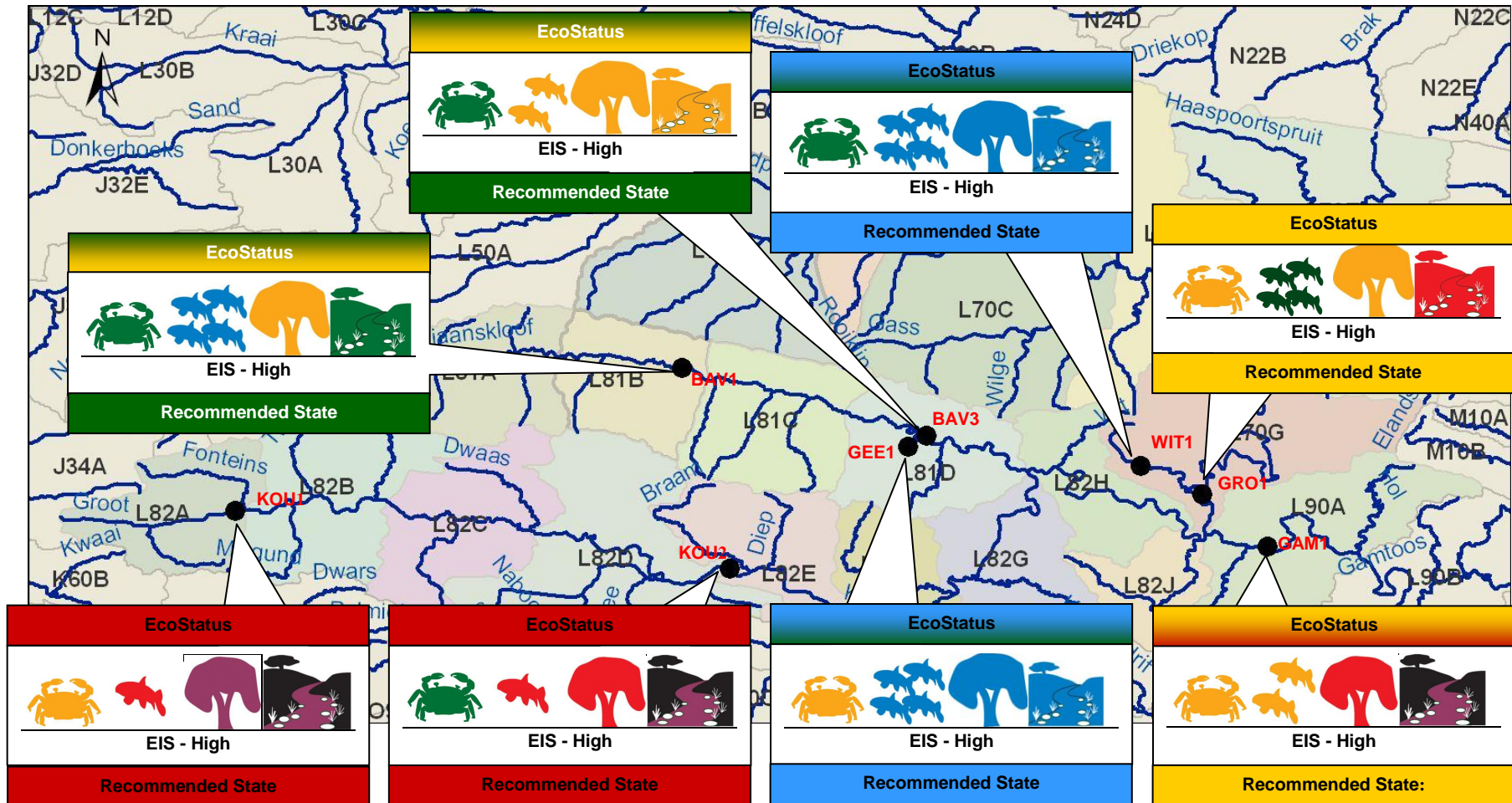
Status of the Baviaanskloof Mega Reserve

The overall status of the Baviaanskloof Mega Reserve is fair. The Baviaanskloof River is in a Good to FAIR state with the Geelhoutbos and Wit Rivers both being in a Natural to Good state. The Lower Groot River is in a Fair state while the Gamtoos River, just downstream of the Kouga dam, is in a Fair to Poor state. The Kouga River itself is in a Poor state as indicated in the pie chart.



There are a number of issues that have been identified that could be impacting the river ecosystems of the Baviaanskloof Mega Reserve, including the following:

- **Abstraction of water** for irrigation and other uses has a serious negative effect on the hydrology and hydraulic component of the aquatic ecosystem which in turn negatively affects the biotic components;
- **Overgrazing** by livestock increase soil erosion which in turn cause the siltation of rivers and reduced water quality (Boshoff 2005);
- **Invasion of alien plants** has a serious negative effect on river channels and amongst others invasive trees fall into rivers and block watercourses (Boshoff 2005);
- **Exotic fish species** that have been introduced into the rivers have the potential to completely eradicate indigenous fish species, some of which are listed on the IUCN Red Data List.
- **Degradation of water quality** in some areas due to human activities such as irrigation and live stock farming as well as ill maintained management roads and 4x4 tracks that introduce nutrients and sediment into the rivers
- **Reduction in flood attenuation** as a result of reduced vegetation cover which is impacted by alien vegetation invasion and clearing as well as overgrazing
- **Increased scouring by floods** as a result of the reduced flood attenuation capacity of catchments which leads to changes in channel morphology and riparian habitat integrity as well as the increased sedimentation of instream habitats.
- **Large impoundments** such as the Beervlei Dam in the upper Groot River and the Kouga Dam on the Kouga River have alter the natural flow regime which result in a negative impact on river ecosystem components such as fish, invertebrates and riparian vegetation.
- **Water transfer schemes** such as the transfer from the Kouga Dam to the Loerie Dam for the purposes of providing water to the NMMP are reducing the availability of water in the Kouga catchment to critical levels potentially prohibiting provision of environmental flows.







State of the Rivers

Upper Baviaanskloof River



EcoStatus

	Good: According to the biological bands (Dallas 2007) for the Southern Folded Mountains (upper) Ecoregion the SASS and ASPT score fall in a B category. Some sensitive indicator taxa were present at the site namely: flow dependent Baetidae and Hydropsychidae spp in SIC biotope, Platycnemidae in the marginal vegetation biotope, and Chlorocyphidae in the cobble biotope. The GSM and water column biotopes harboured more resilient taxa.
	Natural: Velocity depth, cover, flow modification and physico-chemical metrics are considered to be in a natural state. Only migration impacts and risk of exotic species impacting on community structure are evident. The negative impact that introduced exotic species will have on this isolated community is significant. <i>Pseudobarbus afer</i> (cf. Gamtoos) is an important indicator species for the site.
	Fair: The vegetation component is intact with a high diversity of species in all zones. However the extent or cover of the vegetation appears to be declining and is prone to invasion by alien species due to an increase in scouring flood events. <i>Sideroxylon inerme</i> , <i>Widdringtonia schwarzii</i> and <i>Ficus sur</i> are important indicator species for the site.
	Instream habitat – Good: Water abstraction for the irrigation of crops and the presence of exotic macrophytes have a moderate impact on this site with other smaller impacts including water quality, rubbish dumping; flow and channel modifications and inundations due to causeways. Riparian habitat – Good: Channel and flow modifications and inundation due to causeways have a moderate impact. Water quality is also moderately impacted due to increased nutrients from agriculture and possibly human waste. Other smaller impacts include vegetation removal, the presence of exotic vegetation, and bank erosion.
Overall EcoStatus	Good to Fair





Ecological importance and sensitivity

The EIS is **HIGH**. One IUCN Red Data fish species (*Pseudobarbus* sp. 'afer cf. Gamtoos') is expected to occur and the system contains the maximum diversity of fishes for the biome. Protected tree species that occur in the upper catchment include *Sideroxylon inerme* and *Widdringtonia schwarzii*. A large part of the catchment area is managed by Eastern Cape Parks Board and forms part of the Baviaanskloof Mega Reserve conservation area.

Lower Baviaanskloof River



EcoStatus

	<p>Good: According to the biological bands (Dallas 2007) for the Southern Folded Mountains (upper) Ecoregion the SASS and ASPT score fall in a B category. Some sensitive indicator taxa were present at the site namely: flow dependent Baetidae and Hydropsychidae spp and Heptageniidae in the SIC biotope, Platycnemidae in the marginal vegetation biotope, Chlorocyphidae in the cobble biotope. The GSM and water column biotopes harboured more resilient taxa.</p>
	<p>Fair: Cover, flow modification and physico-chemical metrics are considered to be in a natural state. Velocity depth habitat modifications and impact of introduced species are evident at this site. Exotic species have entirely removed the community of indigenous fishes. Conservation intervention required to manage the exotic species. <i>Pseudobarbus afer</i> (cf. Gamtoos) is an important indicator species for the site.</p>
	<p>Fair: The natural vegetation is intact. The channelling of stream bed to accommodate the road has reduced the extent and diversity of Marginal zone vegetation. There is a dominance of <i>Cyperus textilis</i> as a result of increased siltation and nutrient loading in the water. The Upper zone is narrow and difficult to detect while the Lower zone is disturbed by floods, browsing game and livestock (historically), and dominated by <i>Acacia karoo</i> and <i>Rhus pyroides</i>. <i>Sideroxylon inerme</i>, <i>Pittosporum viridifolium</i> and <i>Amphiglossa callunoides</i> are important indicator species for the site.</p>
	<p>Instream habitat- Fair: The presence of exotic fish species has a serious impact on this site. Water abstraction for the irrigation of crops has a moderate impact on the site as well as bed and channel modifications due to presence of the road and the causeway. Eutrophication has a moderate impact on the water quality. Other smaller impacts include rubbish dumping.</p> <p>Riparian habitat – Fair: Channel modification, bank erosion and vegetation removal due to canalisation has a moderate impact. Inundation due to the causeway, eutrophication and flow modifications all contribute to moderate impacts on the riparian zone habitat integrity.</p>
<p>Overall EcoStatus</p>	<p>Good to Fair</p>

Ecological importance and sensitivity

EIS is **HIGH**. One IUCN Red Data fish species (*Pseudobarbus* sp. 'afer cf. Gamtoos') is expected to occur and the study area includes the entire distribution of this local endemic species. The system also contains the maximum diversity of fishes for the biome. Protected trees that occur in this part of the catchment include *Sideroxylon inerme* and *Pittosporum viridifolium* while *Amphiglossa callunoides* has a national status of Threatened and Vulnerable.

A large part of the catchment area is managed by Eastern Cape Parks Board and forms part of the Baviaanskloof Mega Reserve area. Activities such as agriculture and grazing in this part of the catchment can impact negatively on water quality (through e.g. toxicants & nutrients).

Driving Forces for the Baviaanskloof River

Almost the entire catchment of the Baviaanskloof Rivers falls within the Baviaanskloof Mega Reserve conservation area. Issues of concern that have been identified in the Baviaanskloof Mega Reserve where significant pressures are already present, or may occur in the future, include the following¹:

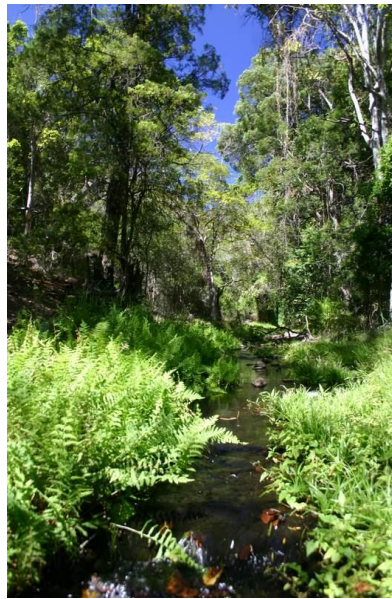
1. Overgrazing by domestic stock (especially goats), followed by accelerated soil erosion, siltation of river systems and reduced water quality, presents a serious threat to biodiversity conservation in parts of the mega-reserve.
2. Increasing demands being made on the area's natural resources, e.g. stock farming is being extended in mountainous areas, with attendant problems caused by new management roads to service these areas, poorly designed 4x4 tracks, and frequent burning to provide grazing for introduced game and domestic stock.
3. Fires started by man and inappropriately located reserve boundaries disturb the natural fire regime, thereby compromising the maintenance of fire-dependent fynbos-dominated vegetation types.
4. Stands of invasive alien shrubs and trees, most notably black wattle (*Acacia mearnsii*), are a threat to both biodiversity conservation and water availability. The stability of the river channels is negatively impacted by invasive alien trees, especially black wattle, which fall into and block river watercourses. Alien plants also increase fuel loads, resulting in frequent and intense fires. Until these are completely eradicated, and all regrowth controlled, they will continue to pose a serious threat.
5. Many of the ancient endemic invertebrate forms in the mega-reserve are aquatic, or have aquatic life phases, emphasizing the need for effective conservation management of the streams and wetlands. These habitats are currently threatened by incompatible land-use practices (e.g. excessive water extraction, canalization of flow, eutrophication from fertilisers) and are also extensively invaded by alien plants and fish. Alien fish prey on the endemic invertebrates, and also on amphibians and indigenous fish.
6. Many of the old forestry management roads and tracks have become badly eroded, as have some of the more recently constructed 4x4 tracks.
7. Large areas of valuable mountain catchment are being converted into croplands in some parts of the mega-reserve's planning region.
8. Because of the high incidence (once every 10 years) of major flood events, the Baviaanskloof is largely unsuitable for crop-based agriculture. Each major flood reduces the area of arable land and reshapes the valley floor. For example, it has been estimated that the 1916 and 1932 floods removed almost half of the arable land in the lower Kouga River catchment. In addition, extensive loss of costly infrastructure, especially roads, causeways and telephone lines, usually accompanies each major flood.

¹ Baviaanskloof Mega Reserve, 2005





Management Responses for the Baviaanskloof River

1. A balance must be maintained between the protection and use of the resource.
2. A conservation plan should be compiled for the red data fish species as well as a management/control/eradication plan for the alien fish species.
3. An indicator/umbrella fish species should be selected that has specific habitat requirements. The community structure of the selected species should be monitored as well as the availability and state of key habitats.
4. Vegetation cover in the catchment should be allowed to recover by reducing or removing livestock from overgrazed and eroding areas in catchment. Vegetation rehabilitation programmes should be put in place and those that are already in place such as the Spekboom reinstatement programme should continue.
5. All alien plant species should be eradicated. Alien eradication programmes should be established and those that are already in place such as the Working for Water programme should continue.
6. In accordance with Baviaanskloof Mega Reserve conservation strategy, the complete cessation of agricultural activities (which includes crop irrigation) in the Baviaanskloof should be investigated.
7. Tourism and other economic activities should be managed through the implementation of an integrated conservation management plan such as the Baviaanskloof Mega Reserve programme.
8. A long term river Health Monitoring Programme for the Baviaanskloof Mega Reserve conservation area must be instated and updated every five years.
9. Natural seasonal flow variability and current water quality must be allowed to persist in order ensure the survival of aquatic biota as well as the cuing of relevant fish and invertebrate breeding behaviours.

Geelhoutbos River



EcoStatus

	<p>Fair: According to the biological bands (Dallas 2007) for the Southern Folded Mountains (upper) Ecoregion the SASS and ASPT score fall in a C category. Some sensitive indicator taxa were present at the site namely: flow dependent Baetidae spp in the SIC biotope, Platycnemidae in the marginal vegetation biotope, Philopotamidae in the cobble biotope. The GSM and water column biotopes harboured more resilient taxa.</p>
	<p>Natural: Velocity depth, cover, flow modification and physico-chemical metrics are considered to be in a natural state. Only migration impacts and risk of exotic species impacting on community structure are evident. The negative impact that introduced exotic species will have on this isolated community is significant. <i>Pseudobarbus afer</i> (cf. Gamtoos) is an important indicator species for the site.</p>
	<p>Natural: The vegetation is pristine and has not been altered. Relatively low occurrence of alien species. The range of cover of the two dominant indicator trees is important. High diversity of non-woody vegetation in Marginal zone. High diversity of woody vegetation in Lower and Upper zones. The catchment is relatively small and managed as wilderness area. Indicator taxa include <i>Sideroxylon inerme</i>, <i>Pittosporum viridifolium</i>, <i>Afrocarpus falcatus</i>, and <i>Widdringtonia schwarzii</i> in the upper catchment and <i>Gasteria rawlinsonii</i> which are succulents occurring on the cliffs.</p>
	<p>Instream habitat - Natural: Water abstraction for the campsite and resulting flow modifications has a small impact. Channel modifications, due to a weir upstream, have a small impact as well as rubbish dumping and the presence of exotic macrophytes. These impacts are all minimal.</p> <p>Riparian habitat - Natural: Affected minimally by vegetation removal for a foot path, channel and flow modifications caused by the weir and water abstraction. Again, all these impacts are minimal.</p>
<p>Overall EcoStatus</p>	<p>Natural</p>

Ecological importance and sensitivity

EIS is **HIFH**. One IUCN Red Data fish species (*Pseudobarbus sp. 'afer cf. Gamtoos'*) is expected to occur and the study area includes the entire distribution of this local endemic species. The system also contains the maximum diversity of fishes for the biome and refugia are available for sensitive, indigenous fish species. Protected trees that occur in the area include *Sideroxylon inerme*, *Pittosporum viridifolium*, *Afrocarpus falcatus*, and *Widdringtonia schwarzii* in the upper catchment. *Gasteria rawlinsonii* which are succulents occurring on the cliffs are listed as rare. The stream dimensions introduce some sensitivity to flow changes. The entire Geelhoutbos catchment is managed by Eastern Cape Parks Board.

Driving Forces

The Geelhoutbos River is located within the Baviaanskloof Nature Reserve. It is in a natural state. Limited impacts occur due to water abstraction, the presence of a weir and the limited removal of vegetation.





Management Responses

1. A balance must be maintained between the protection and use of the resource.
2. A conservation plan should be compiled for the red data fish species.
3. All alien plant species should be eradicated through an alien eradication programme such as the Working for Water programme.
4. Tourism and other economic activities should be managed through the implementation of an integrated conservation management plan such as the Baviaanskloof Mega Reserve programme.
5. A long term river Health Monitoring Programme for the Baviaanskloof Mega Reserve conservation area must be instated and updated every five years.
6. Natural seasonal flow variability and current water quality must be allowed to persist in order ensure the survival of aquatic biota as well as the cuing of relevant fish and invertebrate breeding behaviours.

Wit River



EcoStatus

	<p>Good: According to the biological bands (Dallas 2007) for the Southern Folded Mountains (upper) Ecoregion the SASS and ASPT score fall in a B category. A number of sensitive indicator taxa were present at the site, including: Flow dependent Baetidae and Philopotamidae in the SIC biotope, two highly water quality sensitive taxa namely Amphipoda and Pyralidae in the marginal vegetation biotope and Athericidae in the cobble biotope. The GSM and water column biotopes harboured more resilient taxa.</p>
	<p>Natural: Velocity depth, cover, flow modification and physico-chemical metrics are considered to be in a natural state. Only migration impacts and risk of exotic species impacting on community structure are evident. The negative impact that introduced exotic species will have on this isolated community is significant. <i>Pseudobarbus afer</i> (cf. Gamtoos) is an important indicator species for the site.</p>
	<p>Natural: The vegetation is pristine and has not been altered. Relatively low occurrence of aliens. The extent of cover of the two dominant indicator trees is important. There is a high diversity of non-woody vegetation in Marginal zone as well as a high diversity of woody vegetation in Lower and Upper zones. The catchment is relatively small and managed as wilderness area. <i>Afrocarpus falcatus</i>, <i>Pittosporum viridifolium</i>, and <i>Sideroxylon inerme</i> are important indicator taxa for the site.</p>
	<p>Instream habitat - Natural: The causeway crossing the river results in flow, bed and channel modifications as well as inundation, having a moderate impact on the instream habitat integrity. Riparian habitat - Natural: Inundation is the only noticeable impact on the riparian zone habitat.</p>
<p>Overall EcoStatus</p>	<p>Natural to Good</p>

Ecological importance and sensitivity

EIS is **HIGH**. One IUCN Red Data fish species (*Pseudobarbus sp. 'afer cf. Gamtoos'*) is expected to occur and the study area includes the entire distribution of this local endemic species. The system also contains the maximum diversity of fishes for the biome and refugia are available for sensitive, indigenous fish species. Protected trees in the area include *Afrocarpus falcatus*, *Pittosporum viridifolium*, *Sideroxylon inerme*. Protected forest vegetation types also occur. The stream dimensions introduce some sensitivity to flow changes. Water quality is natural with no water quality impacts in the catchment at present. Part of catchment area is managed by Eastern Cape Parks Board and the river forms part of the Baviaanskloof Mega Reserve conservation area.

Driving Forces

The Wit River is within the Baviaanskloof Nature Reserve and is in a relatively natural state. The water quality is natural and the habitat diversity good, providing good quality habitat for various red data fish species and protected plant species. Limited impact occurs due to the presence of a causeway.


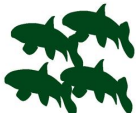


Management Responses

1. A balance must be maintained between the protection and use of the resource.
2. A conservation plan should be compiled for the red data fish species.
3. All alien plant species should be eradicated through an alien eradication programme such as the Working for Water programme.
4. Tourism and other economic activities should be managed through the implementation of an integrated conservation management plan such as the Baviaanskloof Mega Reserve programme.
5. A long term river Health Monitoring Programme for the Baviaanskloof Mega Reserve conservation area must be instated and updated every five years.
6. Natural seasonal flow variability and current water quality must be allowed to persist in order to ensure the survival of aquatic biota as well as the cuing of relevant fish and invertebrate breeding behaviours.

Groot River



EcoStatus

	<p>Fair: According to the biological bands (Dallas 2007) for the Southern Folded Mountains (upper) Ecoregion the SASS and ASPT score fall in a C category. Some sensitive indicator taxa are present at the site, including: flow dependent Baetidae and Hydropsychidae spp taxa in the SIC biotope. The marginal vegetation, GSM and water column biotopes harboured more resilient taxa.</p>
	<p>Good: Minimal impacts affecting velocity depth, cover, flow modifications and physico-chemical metrics. The impact of introduced species is severe. The connectivity is intact, allowing migration of catadromic species. Conservation interventions are required to manage the exotics. Indicator taxa include: <i>P. afer</i>, <i>P. asper</i>, <i>A. mossambica</i>, <i>M.capensis</i> and <i>G. aestuaria</i>.</p>
	<p>Fair: The natural vegetation is intact with a slight decrease in the diversity of vegetation in marginal and lower zones possibly related to an increase in <i>Cyperus textilis</i> cover and extent. There is a local impact of cattle grazing. There is potential for the spread of <i>Typha capensis</i> and <i>Arundo donax</i> and other invasive aliens in the marginal zone. Siltation, causeways, human activities in the greater catchment, as well as an increase in scouring floods has a negative impact on the riparian vegetation. <i>Afrocarpus falcatus</i> is an important historically occurring indicator species for the site.</p>
	<p>Instream habitat - Poor: The poor water quality due to sedimentation and over grazing in the upper regions of the catchment has a serious impact on the instream habitat integrity. The presence of exotic macrophytes also has a large impact. The presence of bridges and weirs has a moderate effect on flow, bed and channel modifications as well as inundation. The presence of exotic fauna also has a large negative impact.</p> <p>Riparian habitat – Poor: Water quality has a large impact on the riparian zone habitat integrity. There is a decrease in indigenous vegetation with an increase in exotic vegetation which has a moderately negative impact. The presence of bridges and weirs has a moderate effect on flow, bed and channel modifications as well as inundation.</p>
<p>Overall EcoStatus</p>	<p>Fair-</p>

Ecological importance and sensitivity

EIS is **HIGH**. Two IUCN Red Data species of fishes occur namely *Pseudobarbus asper* and *Pseudobarbus* sp. 'afer cf. Gamtoos'. This system also contains the maximum diversity of fishes for the biome. Historically, *Afrocarpus falcatus* which is a protected tree species occurred in the catchment. Part of catchment area is managed by Eastern Cape Barks Board and forms part of the Baviaanskloof Mega Reserve conservation area.

Driving Forces

1. The sub-area is approximately in balance (water balance = 0). There are therefore no apparent allocatable quantities in this Groot sub-area according to the yield balance calculations.
2. A small decline in future population is projected for this sub-area, attributable to the predicted lack of further economic growth and the impact of HIV/Aids.
3. Water requirements in the sub-area will likely remain constant, as forecast during the National Demographic study undertaken by DWAF, due to increased per capita water use countering the effects of the decline in population. The growth in urban water requirement as foreseen in the Nelson Mandela Metropolitan Municipality (NMMM) will influence the future water transfers of this sub-area.
4. No opportunities for further water use have been identified. There are no pending license applications and it is very unlikely that further licenses will be granted in the medium term.
5. There are concerns about the extent and impact of large impoundment structures and flood diversion works on the Groot River above Beervlei Dam, used mainly for the opportunistic irrigation of veld.





Management Responses

1. A balance must be maintained between the protection and use of the resource.
2. A conservation plan should be compiled for the red data fish species and a management plan for the alien fish species.
3. An indicator/umbrella fish species should be selected that has specific habitat requirements. The community structure of the selected species should be monitored as well as the availability and state of key habitats.
4. Monitor the diversity of catadromic fishes within the river.
5. Catchment management is necessary to reduce silt loads and reduce input of nutrients into system
6. All alien plant species should be eradicated through an alien eradication programme such as the Working for Water programme.
7. Tourism and other economic activities should be managed through the implementation of an integrated conservation management plan such as the Baviaanskloof Mega Reserve programme.
8. A long term river Health Monitoring Programme for the Baviaanskloof Mega Reserve conservation area must be instated and updated every five years.
9. Natural seasonal flow variability and acceptable (user defined) water quality must be allowed to persist in order to ensure the survival of aquatic biota as well as the cuing of relevant fish and invertebrate breeding behaviours.

Gamtoos River



EcoStatus

	<p>Fair - According to the biological bands (Dallas 2007) for the Southern Folded Mountains (upper) Ecoregion the SASS and ASPT score fall in a C category. Flow dependent indicator taxa were present in SIC biotope namely Baetidae and Hydropsychidae. The marginal vegetation, water column and GSM biotope harboured more resilient taxa.</p>
	<p>Fair - Moderate impacts are affecting the velocity depth, cover, flow modifications and physico-chemical metrics. The impacts of introduced species are severe. The connectivity is intact thus allowing for the migration of catadromic species. Conservation intervention is required to manage the exotics. <i>Pseudobarbus asper</i> and <i>P. afer</i> (cf. Gamtoos) are important indicator taxa for the site.</p>
	<p>Poor – The marginal zone is dominated by cosmopolitan reeds that seem to be spreading and canalizing the river. The lower zone is dominated by open cobble beds that are unstable and highly prone to invasion by alien vegetation. The upper zone is poorly developed and lost to agriculture in many parts. There is a serious reduction in natural species diversity. Historically, <i>Afrocarpus falcatus</i> which is a protected tree species occurred in the catchment.</p>
	<p>Instream habitat – Seriously modified: The instream habitat integrity of the Gamtoos River is seriously impacted by water abstraction for irrigation as well as flow modifications due the Kouga Dam upstream of the site. Intensive infestations of exotic macrophytes are a serious impact on the system. Even though natural diversity of fish species still occurs, the presence of exotic fish species is of great concern. The water quality is also impacted by siltation and eutrophication. Algae are present on cobbles and other substrata. Channel modification occurs due to causeways and farm dams.</p> <p>Riparian habitat - Critically modified: Flow modification and water abstraction have a serious impact on the riparian zone habitat integrity. Indigenous vegetation is decreasing due to agricultural activities as well as intensive alien vegetation encroachment. Inundation, channel modification as well as water quality alteration have serious negative impacts on the system.</p>
<p>Overall EcoStatus</p>	<p>Fair to Poor</p>

Ecological importance and sensitivity

EIS is **HIGH**. Two IUCN Red Data species of fishes occur namely *Pseudobarbus asper* and *Pseudobarbus sp. 'afer cf. Gamtoos'*. This system also contains the maximum diversity of fishes for the biome and includes the entire distribution of local endemic Red Data listed fish (*Pseudobarbus sp. 'afer cf. Gamtoos'*). Estuarine fish species and anadromic Eels have migrated into and occupy this reach. Connectivity provided through this reach into the Groot River which is intact should be maintained.

Historically, *Afrocarpus falcatus* which is a protected tree species occurred in the catchment. Part of catchment area is managed by Eastern Cape Parks Board and forms part of the Baviaanskloof Mega Reserve conservation area.

Driving Forces

The abstraction of water for irrigation has a serious impact on this system. Intensive irrigation agriculture is practiced alongside the river where vegetables, fruit and tobacco are produced. Pesticide residues are generally associated with the production of these crops and may be an issue of concern in terms of the water quality requirements of aquatic biota. The extent and impact of alien plants in the sub-area is unacceptable. Because of the high incidence (once every 10 years) of major flood events, there is a significant risk of periodic devastating flooding along the lower Garтоos River.





Management Responses

1. A balance must be maintained between the protection and use of the resource.
2. A conservation plan should be compiled for the red data fish species and a management plan for the alien fish species.
3. An indicator/umbrella fish species should be selected that has specific habitat requirements. The community structure of the selected species should be monitored as well as the availability and state of key habitats.
4. Monitor the diversity of catadromic fishes within the river.
5. Catchment management is necessary to reduce silt loads and reduce input of nutrients into system.
6. Human activities in the catchment should be managed through the implementation of an integrated catchment management plan.
7. All alien plant species should be eradicated through an alien eradication programme such as the Working for Water programme.
8. A long term river Health Monitoring Programme for the area must be instated and updated every five years.
9. Natural seasonal flow variability and acceptable (user defined) water quality must be allowed to persist in order to ensure the survival of aquatic biota as well as the cuing of relevant fish and invertebrate breeding behaviours.

Kouga River Upstream



EcoStatus

	<p>Fair - According to the biological bands (Dallas 2007) for the Southern Folded Mountains (upper) Ecoregion the SASS and ASPT score fall in a C category. Flow dependent indicator taxa present in SIC biotope include Baetidae. The marginal vegetation biotope harboured one highly water quality sensitive indicator taxon namely Pyralidae. The GSM and water column biotopes harboured more resilient taxa.</p>
	<p>Poor – There are moderate impacts affecting the velocity depth, cover, flow modifications and physico-chemical metrics. The impacts of introduced species are severe. The connectivity has been removed not allowing migration of catadromic species. The severity of the impact is related to predation by exotic species. Conservation intervention is required to manage the exotic species. <i>P. afer</i> (cf. Gamtoos) is an important indicator taxon for the site.</p>
	<p>Seriously modified: Open sandy banks dominate the site with a serious loss of species diversity and vegetation cover. Invasion and clearing of black wattle has a serious negative impact. There is a high potential for re-invasion with exotic vegetation.</p>
	<p>Instream habitat – Seriously modified: Upstream dams, roads, weirs and causeways result in inundation and flow modification as well as bed- and channel modification. Abstraction for irrigation leads to flow modification and has an impact on water quality due to amongst others eutrophication resulting from return flows. Other impacts include human settlement and the presence of solid waste from a burst sewerage pipe, high sedimentation loads, as well as the presence of exotic fish species. These aspects all result in a serious impact to the instream habitat integrity.</p> <p>Riparian Zone Habitat – Critically modified: Alien invasive plants, scouring floods and agriculture are resulting in bank erosion and a decrease in the presence of indigenous vegetation. Other large impacts include water abstraction, inundation as well as flow and channel modification. Eutrophication and sedimentation are impacting on the water quality which in turn impacts on the riparian habitat integrity.</p>
<p>Overall EcoStatus</p>	<p>Poor</p>





Ecological importance and sensitivity

EIS is **HIGH**. One IUCN Red Data fish species (*Pseudobarbus sp. 'afer cf. Gamtoos'*) is expected to occur and the study area includes the entire distribution of this local endemic species. The system also contains the maximum diversity of fishes for the biome. Part of the catchment area is managed by Eastern Cape Nature Conservation and falls within the Baviaanskloof Mega Reserve conservation area.

Kouga River Downstream



EcoStatus

	<p>Good - According to the biological bands (Dallas 2007) for the Southern Folded Mountains (upper) Ecoregion the SASS and ASPT score fall in a B category. Sensitive flow dependent taxa were present in SIC biotope namely more than 2 spp Baetidae and Hydropsychidae, Heptageniidae and Philopotamidae. The cobble biotope harboured two sensitive taxa namely Athericidae and Chlorocyphidae. The GSM, marginal vegetation and water column biotopes harboured more resilient taxa.</p>
	<p>Poor - There are moderate impacts affecting the velocity depth, cover, flow modifications and physico-chemical metrics. The impacts of introduced species are severe. The connectivity has been removed not allowing migration of catadromic species. The severity of the impact is related to predation by exotic species. Conservation intervention is required to manage the exotic species. <i>P. afer</i> (cf. Gamtoos) is an important indicator taxon for the site.</p>
	<p>Poor - The extent of cover of palmiet (<i>Prionium serratum</i>) and <i>Salix mucronata</i> is low due to the predominance of scouring floods. Relatively low extent of cover of woody trees and bushes occur. The impact of alien vegetation invasion and removal of black wattle as well as the damage caused during floods by alien vegetation debris is severe. <i>Pittosporum viridifolium</i> is an important indicator species for the site.</p>
	<p>Instream habitat – Seriously modified: Upstream dams as well as abstraction for irrigation and rural settlements results in flow and channel modification. Water quality is impacted negatively by high sedimentation loads and eutrophication. Other impacts include bed modification due to road infrastructure, the presence of animal and human waste as well as the presence of exotic fish species. All these issues result in a serious impact to the instream habitat integrity. .</p> <p>Riparian habitat – Critically modified: Alien invasive plants, scouring floods and agriculture are resulting bank erosion and a decrease in the presence of indigenous vegetation. Other large impacts include water abstraction, inundation, flow and channel modification. Eutrophication and sedimentation negatively impact water quality.</p>
<p>Overall EcoStatus</p>	<p>Poor</p>

Ecological importance and sensitivity

EIS is **HIGH**. One IUCN Red Data fish species (*Pseudobarbus* sp. 'afer cf. Gamtoos') is expected to occur and the study area includes the entire distribution of this local endemic species. Substrate at this reach provides limited cover from predation by Exotic Bass and Sharptooth Catfish. *B. pallidus* still occurs here as a result. The system contains the maximum diversity of fishes for the biome. Protected trees that occur in the area include *Pittosporum viridifolium*. Part of the catchment area is managed by the Eastern Cape Parks Board and falls within the Baviaanskloof Mega Reserve conservation area.

Driving Forces for the Kouga River

1. The Kouga River could come under severe stress if the irrigation farmers below the Kouga Dam take up their full quota. There is therefore no allocatable water in this sub-area according to the yield balance calculations. No new licenses will therefore be granted in the medium term.
2. Water requirements in the sub-area will likely remain constant, as forecast during the National Demographic study undertaken by DWAF. The growth in urban water requirement as foreseen in the NMMM will influence the future water transfers from this sub-area. Future augmentation of supply is planned for the urban water requirement of NMMM via the Guernakop Dam in the Kouga River which was identified as a likely potential future source to NMMM.
3. The extent and impact of alien plants in the sub-area is unacceptable. It is estimated that the impact of alien vegetation will increase significantly in the next 5 to 10 years, resulting in the loss of much, or possibly even all, of the available water in certain catchment areas.

Management Responses for the Kouga River

1. A balance must be maintained between the protection and use of the resource.
2. A conservation plan should be compiled for the red data fish species and a management plan for the alien fish species.
3. An indicator/umbrella fish species should be selected that has specific habitat requirements. The community structure of the selected species should be monitored as well as the availability and state of key habitats.
4. Catchment management is necessary to reduce silt loads and reduce input of nutrients into system.
5. Human activities in the catchment should be managed through the implementation of an integrated catchment management plan.
6. All alien plant species should be eradicated. Alien eradication programmes should be established and those that are already in place such as the Working for Water programme should continue.
7. A long term river Health Monitoring Programme for the area must be instated and updated every five years.
8. Natural seasonal flow variability and current water quality must be allowed to persist in order to ensure the cuing of relevant fish and invertebrate breeding behaviours

List of acronyms

ASPT	Average Score Per Taxon
CMA	Catchment Management Agency
DEAT	Department of Environmental Affairs and Tourism
DWAF	Department of Water Affairs and Forestry
EC	Ecological Category
EIS	Ecological Importance and Sensitivity
FRAI	Fish Response Assessment Index
GSM	Gravel, Sand, Mud
IHI	Index of Habitat Integrity
IUCN	International Union for Conservation of Nature
IWRM	Integrated Water Resources Management
MIRAI	Macro-Invertebrate Response Assessment Index
NMMM	Nelson Mandela Metropolitan Municipality
PES	Present Ecological State
PPT	Provincial task team
RHP	River Health Programme
SASS5	South African Scoring System (Version 5)
SIC	Stones in current
SOOC	Stones out of current
SoR	State-of-Rivers
VEGRAI	Vegetation Response Assessment Index
WRC	Water Research Commission

Glossary

Biotic index: A numerical index which uses one or more components of the biota to provide a measure of the biological condition of a site.

Biotope: An area of uniform environmental conditions and biota.

Diatoms: A type of algae that has a cell wall made almost entirely of silica.

EcoClassification: An abbreviation for the Ecological classification process used to determine and categorise the Present Ecological State (PES) of the different biophysical attributes of rivers in relation to the natural or close to natural reference condition.

Ecoregion: Regions that are grouped together because of the relative homogeneity in their ecological characteristics or in the relationships between organisms and their environments. The boundaries are not distinct and one region merges into the next.

EcoStatus: Short for "Ecological Status", is the totality of features and characteristics of the river and its riparian areas that bear upon its ability to support an appropriate natural fauna and flora and its capability to provide a variety of goods and services.

Index: A ratio or number derived from a series of observed facts; can reveal relative changes as a function of time.

Invertebrate: An animal that has no backbone and internal skeleton.

Macroinvertebrate: An invertebrate that is visible to the naked eye.

Monitoring: The measurement, assessment and reporting of selected properties of water resources in a manner that is directed at well defined objectives.

Present Ecological State (PES): The current state of a river compared to the natural or close to natural reference condition. It is expressed in terms of drivers (hydrology, geomorphology and physico-chemical) and biological responses (fish, aquatic invertebrates and riparian vegetation) as well as an integrated state – the EcoStatus.

Reference Condition: An expected condition that reflects natural or near natural (least-impacted) physical, chemical and biological characteristics of a site, river reach or river type, in the absence of anthropological stress

Water quality: This includes the physical, chemical, toxicological, radiological, biological and aesthetic properties of water that determines the fitness for use or that are necessary for protecting the health of aquatic ecosystems. The water quality is reflected in the concentration of substances, physico-chemical attributes, levels of radioactivity and biological responses to those concentrations, physico-chemical attributes or radioactivity.

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