52 AWARD Tech Report Series

Ecosystem Services Assessment

Upper Sand River Catchment

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USAID: RESILIENCE IN THE LIMPOPO BASIN PROGRAM (RESILIM) - OLIFANTS

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Ecosystem Services Supply and Demand

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1 Executive summary

The Lowveld Plantations covering the Upper Sand River Catchment has been earmarked for land restitution to communities who were removed from the area in the past. The area was recently managed as a State Forest, with extensive plantations and indigenous forests, but currently various changes in terms of land-uses taking place in the area are envisioned. Given the key role that the Upper Sand River Catchment continues to play in supplying downstream water to the Bushbuckridge area and the need to generate economic benefits for the Communal Property Associations (CPA; beneficiaries of land restitution), it is necessary to understand the trade-offs between different land-use options for the area.

The project employed the *EcoFutures* participatory modelling process to develop a better understanding of the possible trade-offs by modelling a suite of plausible future land use scenarios. The participatory modelling process involved local, provincial and national stakeholders in assessing the supply of and demand for ecosystem services in the Upper Sand Catchment for a range of future scenarios. Importantly, the modelling outcomes are a product of the discussions of the stakeholders, with the report reflecting the understanding and perspectives of the stakeholders.

Figure A shows the relative magnitude of the different ecosystem service levels supplied by the affected area at the current time (February 2020). Note the relatively abundant services supplied (biodiversity conservation targets, adventure recreation and carbon storage) and the relatively scarce services supplied (transport access, surface water supply and food crops).

A series of future scenarios were developed by the workshop participants to analyse changes to ecosystem services and associated human benefits, and included a ‘do nothing’ scenario, a ‘maximise private benefits’ scenario and a ‘win-win’ scenario. In these scenarios, different land uses were developed, and any possible associated impacts extrapolated, resulting in associated changes to the size (in hectares), condition (scores) of existing landscape assets, and to the levels of associated ecosystem services supplied.

Figure B shows how the services supply levels are likely to change in the different scenarios, with the red line constituting the current supply level (with each service depicted as 100% of current supply level). The percentage change in different scenarios is reflected by the different scenario lines. In the ‘do nothing’ scenario, there is a serious decline in all services, and warns against a future where on-going delays in the transfer of ownership will and associated developments lead to serious wellbeing losses for society. Note that for the ‘maximise private benefits’ scenario selected services such as fibre, fuelwood, food crops, pollination, flood damage control and transport access – all increase significantly, given the possible growth in plantations and food crops. On the other hand, this scenario also generates a reduction in key public service benefits such as surface water supply, dry season flows and conservation targets. The ‘win-win’ scenario, which includes some plantation forestry, agriculture development and tourism, results in a significant growth in public and private benefits. The ‘win-win’ scenario offers both public and private benefits and is clearly the societal optimal option.

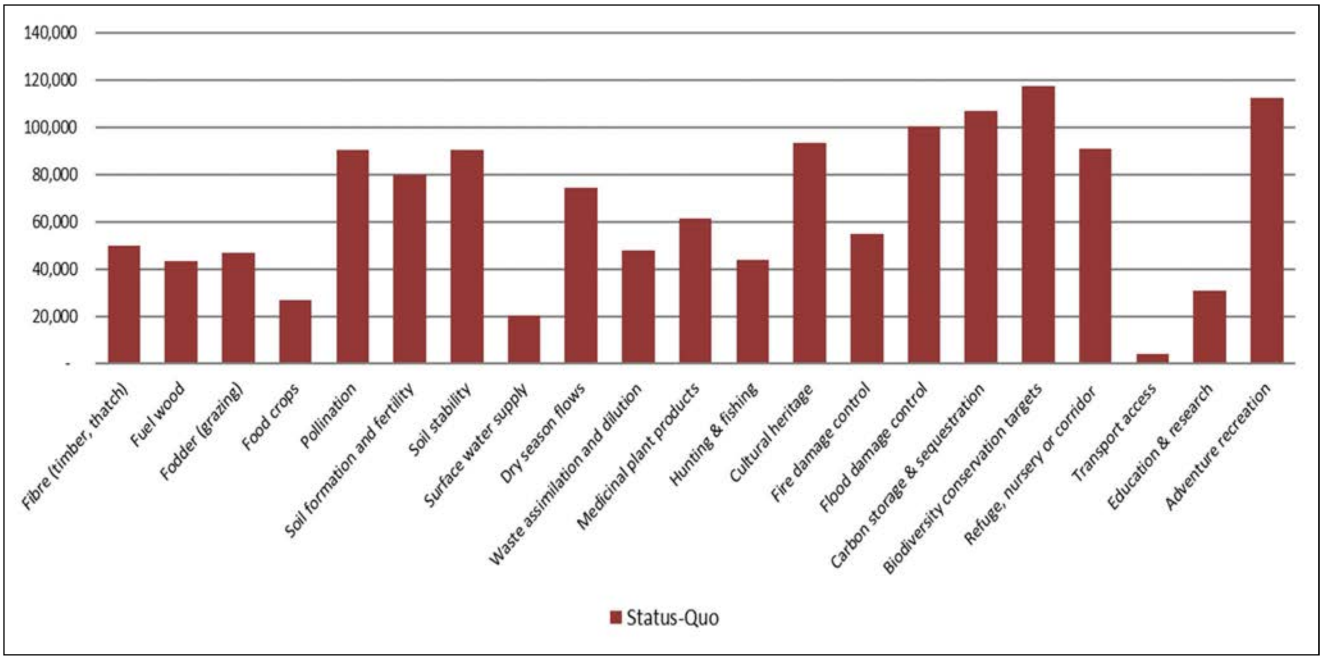

Figure A: Relative ecosystem service levels in the catchment
(the units are an index with the highest being relatively most abundant and the lowest being relatively least abundant)

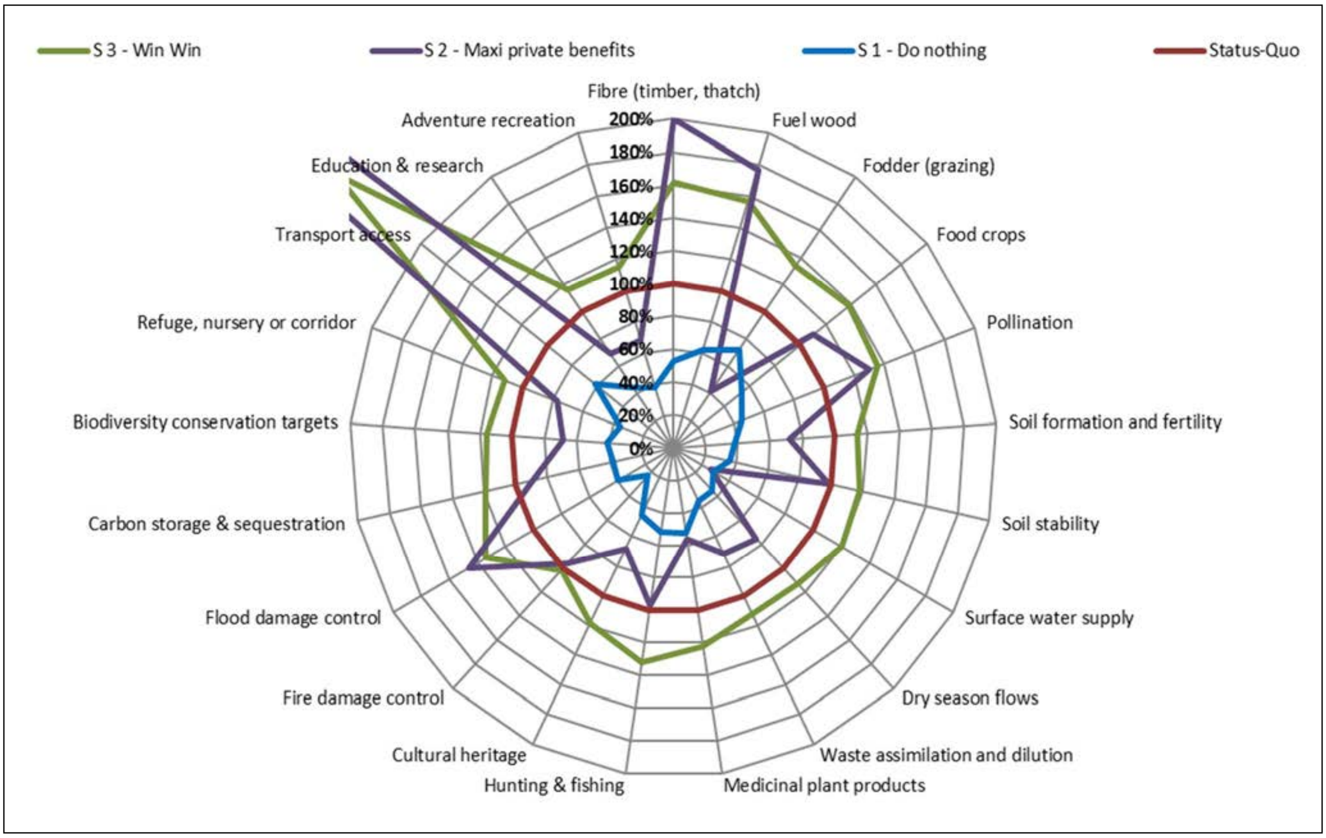

Figure B: Changes in the supply of ecosystem services in different scenarios in the affected area
(the red line shows supply at 100% of current levels.)

In considering the changes in services supply, the question that begs answering is –

How significant are these changes to human welfare?

To answer this question, the ECOFUTURES process captures the numbers of services users and their relative dependence on these services, and generates an index, the human benefit index[1], so that the trade-offs between choices can be compared.

The workshop identified that biodiversity conservation service has the highest benefit index as the entire Mpumalanga population benefits from conservation. The second highest benefit index was attributed to surface water supply and included local households abstracting water (either fulltime or due to reticulated supply breakdowns), cattle owners, game reserve owners and users, and downstream irrigators. The third highest index was the dry season flow users, and these users show a very high level of dependence on the services. In other words, there are few alternative supply options for dry season flows, and significant welfare losses will occur if access to dry season flows decline. For example, if cattle owners and water users augmenting reticulation breakdowns, cannot access dry season flows then they will experience significant hardships (health or income). It is important to note that numerous other services, such as fodder, pollination, cultural heritage, fire damage, waste assimilation and dilution (water quality), fire and flood damage control, fibre and road access (to plantations) – all have high importance to the current users, even if their numbers are smaller than the water supply users.

The demand for services (using the human benefit index as a proxy) helps prioritise which services to focus on, and therefore what supporting natural capital to prioritise for management. The demand for services also shows which user groups could be engaged in order to access resources or political support for effectively managing the area. For example, engaging with provincial authorities to garner support for forest conservation, and engaging with local authorities to get support for downstream water security maintenance. Furthermore, commercial products like fibre (timber), indicate that timber companies should be engaged.

[1] *The human benefit index is calculated by multiplying the number of users by their respective levels of dependency. See Cartwright, A., Blignaut, J., De Wit, M., Goldberg, K., Mander, M., O'Donoghue, S. and Roberts, D. 2013. Economics of climate change adaptation at the local scale under conditions of uncertainty and resource constraints: the case of Durban, South Africa. Environment and Urbanization published online 6 March 2013.*

In summary:

1. The Upper Sand Catchment consists of both natural and transformed land cover types, with some habitats such as forests, in good condition, while other such as plantations are in poor condition.

2. A wide range of services are supplied by the Upper Sand Catchment.

3. The supply of these services is not certain. A ‘do nothing’ scenario (that is – a continuation of the status quo) will lead to a serious decline in all services. This implies that urgent management is required in the short term, irrespective of ownership.

4. A ‘win-win’ scenario has the capability to meet both CPA needs and societal needs effectively.

5. The demand for services is diverse, with CPA needs, neighbouring community needs, downstream water needs, provincial needs and even international needs (Maputo City water users).

6. There are high levels of dependence on the Upper Sand Catchment and any land use in the area needs to take these into consideration.

7. The supply of services and therefore user benefits, are at risk in ‘do nothing’ and ‘maximise private benefits’ scenarios. Key service user beneficiaries should be engaged to garner resources and political support for avoiding the ‘do nothing’ scenario.

2 Project background & Objectives

The Blyde Restoration project is focused on the ecological restoration and sustainable management of the Blyde, Sand and Klaserie Catchments through a collaborative partnership called the Blyde Restoration Working Group. The overall aims of the project and group are focussed on improving and maintaining water security, biodiversity conservation, development of natural resource based livelihoods, and the development of custodianship. The project was initiated in 2015 as part of the USAID RESILIM-Olifants Programme implemented by AWARD. Following a successful LUI application, DEFF NRM has become the main funder in 2020.

The objectives for the LUI Blyde Restoration project were developed through consideration of the five major objectives of the LUI Operational Support and Planning section and the objective of the Groen Sebenza programme, along with the original objectives of the Blyde Restoration Working Group & Project.

The objectives include the following:

1. To collaboratively develop and support implementation of a long-term integrated restoration and maintenance strategy for the prioritization of NRM work in securing ecosystem services and biodiversity in the upper Blyde, Klaserie & Sand Catchments
2. To support the development of custodianship & build collaborative partnerships and institutional arrangements for collective restoration and NRM practices
3. To support the capacity development of practitioners on key technical skills for restoration planning and implementation in the upper Blyde, Klaserie & Sand Catchments
4. To facilitate social learning, co-learning, sharing experiences & approaches amongst partners and practitioners in the Natural Resource Management sector
5. To develop a collaborative, systemic understanding of the context and impacts of restoration in the Blyde and key neighbouring catchments
6. To mentor and develop young Natural Resource Management professionals

The work outlined in this report is in support of several objectives, in particular objectives one, two and five (while housed as deliverable under objective 5).

3 Background to Ecosystem services assessment

The water security, biodiversity conservation and human livelihoods value of these three catchments are generally well recognised, but the need to develop a better understanding of the various ecosystem services generated by these catchments were noted early on during the project's collaborative assessment process with partners. Partners also noted the need for inclusive and participatory approaches supporting the development of a collective understanding amongst various catchment stakeholder groups. A more detailed and participatory assessment would assist with a number of aspects in relation to restoration, as well as the future land-use and development aims for the landscape post-restoration. These included:

- Identification of key parts of the landscape (or specific vegetation types) providing key services, especially water provision, in order to guide prioritization of restoration activities (along with degradation information) and hence securing of these specific services.
- Assessing the potential benefits (improved or assured ecosystem services) which would be generated if degraded areas of the catchments were restored and maintained to inform cost-benefit analyses of restoration (through a modelling or scenarios approach), and providing a sound rationale for restoration investments in these catchments.
- Getting a better understanding of how different natural resources or services were valued by catchment residents, as well as different stakeholder groups amongst these, so that restoration and restoration outcomes could be aligned with the needs and wishes of such stakeholder groups.
- Restoration activities also clearly need to be aligned with future land-use and development plans, while future land-use activities equally need to be informed by existing restoration objectives (ensuring that these do not conflict).

A participatory ecosystem services assessment for these three catchments would present a significant undertaking, and given funding constraints, it was decided to conduct an initial assessment within the Sand Catchment only. The land-use history of the Upper Sand Catchment, the large number of downstream residents (relying on various ecosystem services from the area), as well as the land-ownership, land-use and land-management changes this area is undergoing (and will further undergo) were key reasons for this selection (see next section for more details). It was also hoped that a smaller process would allow a more meaningful and iterative learning process for all parties involved (including ourselves).

4 Upper Sand catchment & Lowveld Plantations context

The Upper Sand River Catchment is located along the Drakensberg Escarpment within the Mpumalanga Province. This area, along with the adjacent upper Blyde and Klaserie River Catchments on which the Blyde Restoration Project is focused, receives very high amounts of rainfall and forms part of the national Strategic Water Source Areas within the Mpumalanga Drakensberg Node. Given this the area is of vital importance to the water security and the livelihoods of downstream residents of the Bushbuckridge Local Municipality. In addition to water, it also provides a range of water- and land-based ecosystem services supporting a number of socio-economic activities, both within the upper catchment and downstream.

The Upper Sand River Catchment is located within the Lowveld Plantations, which have been managed as a State Forest with large scale plantation forestry since the first half of the twentieth century (currently managed by DEFF Forestry). Various catchment orientated studies and projects during the 1990's and early 2000's, including the Kruger National Park Rivers Programme and the Save-the-Sand project, highlighted the negative impact of these plantations and their associated management activities on the Sand Catchment. Based on recommendations from this work as well as further stakeholder inputs, these plantations were decommissioned in 2002 by cabinet decision. The intention with this decision was to ecologically restore these areas, with their subsequent inclusion in a future Blyde National Park along with the adjacent Blyde River Canyon Nature Reserve (Blyde NR), supporting both longer term water security and biodiversity conservation.

This decision was reviewed and amended through a further cabinet decision in 2012 (following further stakeholder consultation), with the lower, eastern quarter of the plantations being re-commissioned for forestry, given the need for timber, firewood and forestry related economic opportunities by residents in the adjacent communal area of Bushbuckridge. The remaining three-quarters were still aimed for restoration, and are now to be incorporated into the Blyde NR (managed by MTPA), with the collapse of the national park process in the mid-2000s.

During the mid-1990's and throughout the above process, various restoration projects were initiated in the area including invasive alien plant control, plantation removal (following decommissioning), erosion-control, and wetland restoration. To date well over R300 million has been invested in these restoration initiatives in the area since the early 1990's (which probably constitutes one of the longest and largest ongoing restoration efforts in SA). Most of these efforts are ongoing and are funded and implemented by the DEFF Natural Resource Management Programmes (NRMPs) and various other government, private and NGO partners (including several Land User Incentives projects).

In tandem with all the above processes, the Lowveld Plantations (along with the Blyde NR) have also been earmarked for land restitution to communities who were forcefully removed from the area during the establishment of plantation forestry. The vision of the restituted landowners, constituted by four Communal Property Associations (CPAs), is to play a direct and increasing role in the conservation and natural resource management, and hence the custodianship of this area. The CPAs also have a strong focus on the development of sustainable natural resource based land-use activities and the socio-economic development of their members.

To facilitate this they have engaged with various potential partners and stakeholders within the restoration, conservation, eco-tourism and forestry sectors.

In the context of the above restoration, conservation, natural resource management, forestry, and socio-economic development plans and work, several partnerships have been developed amongst the various stakeholders involved in the area from 2014 onwards. This has included representatives from various government, land-owner and community, private sector, and NGO entities, and has been facilitated by AWARD and the K2C through a number of projects. These partnerships are aimed at collectively supporting the continuation (or completion) of these processes, while addressing a number of challenges that have hampered these processes, and exploring new emerging opportunities. These partnerships have focussed on the establishment and functioning of various representative communication and decision-making platforms and structures, agreements amongst specific parties, the development of several plans and strategies to guide restoration and other natural resource management practices, as well as the actual development and implementation of projects.

Many of the objectives and activities of the above work need to be aligned with and informed by the future land-uses and economic activities envisioned on the land by the CPAs and other key stakeholders. Given the above outlined broader land-use intentions, the key role the area plays in supplying downstream water to the Bushbuckridge area, and the need to generate economic benefits for the CPAs, it is necessary to understand the various benefits and dis-benefits of different land use options, as well as the trade-offs between different land uses. The ECOFUTURES process was employed to develop a better understanding of the possible trade-offs by modelling a suite of plausible future land use scenarios. This will inform the various ongoing planning and implementation processes, in order for these to be enabling and supportive of the socio-economic and land-use developments envisioned by the group of key stakeholders.

5 The ECOFUTURES participatory modelling process

The ECOFUTURES process combines both available data and knowledge and experience, in an agent-based modelling workshop, to understand system linkages and to predict future changes in the social-ecological system. The process includes the development of a systems model to outline and understand the status-quo situation (the baseline) of the affected area, in terms of ecosystem services, and then models the implications of several plausible scenarios that could emerge in and around the Upper Sand River Catchment.

Figure 1: Participatory Ecosystem Services Assessment workshop on 25-26 February 2020 focussed on the Upper Sand River Catchment

The modelling process generated indicators of:

- The natural capital (or natural assets) and other landscape assets in the Upper Sand River Catchment (its size and condition);
- The ecosystem services supplied and their relative supply levels (not actual levels);
- The number of service users and the benefits generated through use (using a Human Benefit Index);
- The direction and magnitude of ecosystem services change in different land use and local development scenarios.

The process uses ecosystem services as the currency of measuring change – as it is through changes in ecosystem services that humans experience landscape changes. Ecosystem services are the outputs of nature that generate services for people. Ecosystem services are generated by both natural and transformed landscapes. It is important to note that ecosystem services are not the same as ecosystem functions. Functions are the biological, chemical and physical processes associated with natural ecosystems. Services are the results or outputs of those processes which people use – either directly or indirectly.

The indicators of change should be used to inform the future land uses in the catchment.

The participatory modelling process involved stakeholders in assessing the supply of and demand for ecosystem services in the Upper Sand Catchment for a range of future scenarios. The process used is outlined below:

- The boundaries of the focus area were demarcated and available data on land cover (incl. the latest National Landcover map, National Vegetation map, and a road and track datasets) in the area was collated within a Geographic Information System (GIS). The main land cover types within the area were defined and delineated based on an integration of the above data sources to determine their geographic location and size (in hectares).
- A social-ecological systems model of the area was built using Excel.
- A field visit to the site was undertaken with the AWARD & DEFF NRM team on the 24th February 2020 in order to develop a better understanding of the bio-physical context and status of the area as well as the downstream socio-economic context.
- The participatory modelling workshop with local stakeholders and experts was conducted in Hoedspruit on 25 and 26 February 2020, in order to model the supply and demand for ecosystem services (see Figure 1). The workshop process shared understandings of stakeholders and experts see Table 1), (and developed new insights in terms of:
    - Ecosystems' and transformed landscapes' (such as plantations and croplands) conditions and functionality.
    - Ecosystem services supply potentials for the different categories of natural assets (rivers, riparian forests, forests, wetlands, etc) and other landscape features (such as plantations, croplands, settlements and roads).
    - Ecosystem services supply levels per land cover type.
    - The numbers of ecosystem services' users in terms of onsite, offsite and downstream demands.
    - The relative dependency of the users on the selected ecosystem services.
    - The workshop process was participatory by developing consensus on the relative scores of the above model inputs. The process developed scores for the above range of variables by using available data, local experiences or wisdom, or a combination of these elements. Where data was available, this was used to inform scores, but in the absence of data, a discussion was held to develop a baseline score. The process focused on orders of magnitude estimates.
- Once a baseline model was established representing the status quo, the participatory workshop then evaluated changes to service supply levels in future scenarios and included:
    - A 'do nothing' scenario, a 'maximise private benefits' scenario and 'win-win' scenario. All three scenarios used the same 20 years' time frame, that is, the scenarios described a situation in the year 2040.

- Discussing the change in land use in the different possible future scenarios and then estimating changes in land cover in terms of:
    - Estimating changes to land cover types in the affected area (in hectares) due to the different land use options.
    - Switching the allocation of areas between different land cover types, such as reducing plantations and replacing them with woodlands, or increasing croplands, etc.
    - Changing the condition or state of the natural assets and land cover types in response to the likely future land uses and their associated management efficiencies / approaches and local population pressures.
    - Systematically reflecting on the consequences of changes in the landscape in relation to hydrological systems, such as when an upstream riparian forest is degraded, with the impacts on downstream rivers identified and scored.

- The outcomes, in terms of services supply and their associated demands were then modelled and reviewed. Any anomalies were discussed and either accepted, or if required, changes were made to the criteria scores to address anomalies.
- Importantly, the modelling outcomes are a product of the discussions of the stakeholders, with the report reflecting the opinions and perspectives of the stakeholders.

TABLE 1: LIST OF WORKSHOP PARTICIPANTS AND THEIR RESPECTIVE ORGANIZATIONS

NAME	ORGANIZATION	NAME	ORGANIZATION
Brendon Mashabane	DEFF NRM Mpumalanga	**Myles Mander**	FutureWorks (facilitator)
Cynthia Sibuyi	Sabi-Sand Wildtuin Community	**Noxolo Mbebe**	AWARD
Dineo Mogakane	K2C Environmental Monitor	**Obed Mogane**	DEFF NRM Mpumalanga
Eddie Riddell	SANParks, Kruger National Park	**Pat Seoke**	DEFF Forestry
Godfrey Monareng	Mahubahuba-a-Bokone CPA	**Reuben Thifhulufhelwi**	AWARD & Rhodes University
Isaac Hlatswayo	Sabi-Sand Wildtuin	**Romy Antrobus-Wuth**	K2C
Jan Graf	AWARD	**Sarah Polonsky**	DEFF NRM National
Joanne Taylor	Aves Africa	**Sharon Pollard**	AWARD
Justice Zandamela	DEFF NRM Mpumalanga	**Silindile Mtshali**	AWARD
Lientjie Cohen	MTPA	**Timothy Mashile**	Maorabjang CPA
Lisa Wright	Bushwillow Communications	**Tlayishego Pebane**	K2C Environmental Monitor
Lourence Mogakane	Mahubahuba-a-Bokone CPA	**Tshembile Mathonsi**	SANParks BSP
Mbali Mashele	K2C-SANParks	**Vutlhari Matsane**	IUCMA
Moses Mashile	Sethlare CPA	**Wayne Twine**	Wits Rural Facility
Moses Mathabela	Conservation South Africa	**Winners Mashego**	DEFF Forestry
Mthobisi Soko	IUCMA		

6 The key land cover types & ecosystem services supplied

6.1 The ecosystem assets, location and types of services supplied

For modelling purposes, a land cover map was developed. See Figure 2.

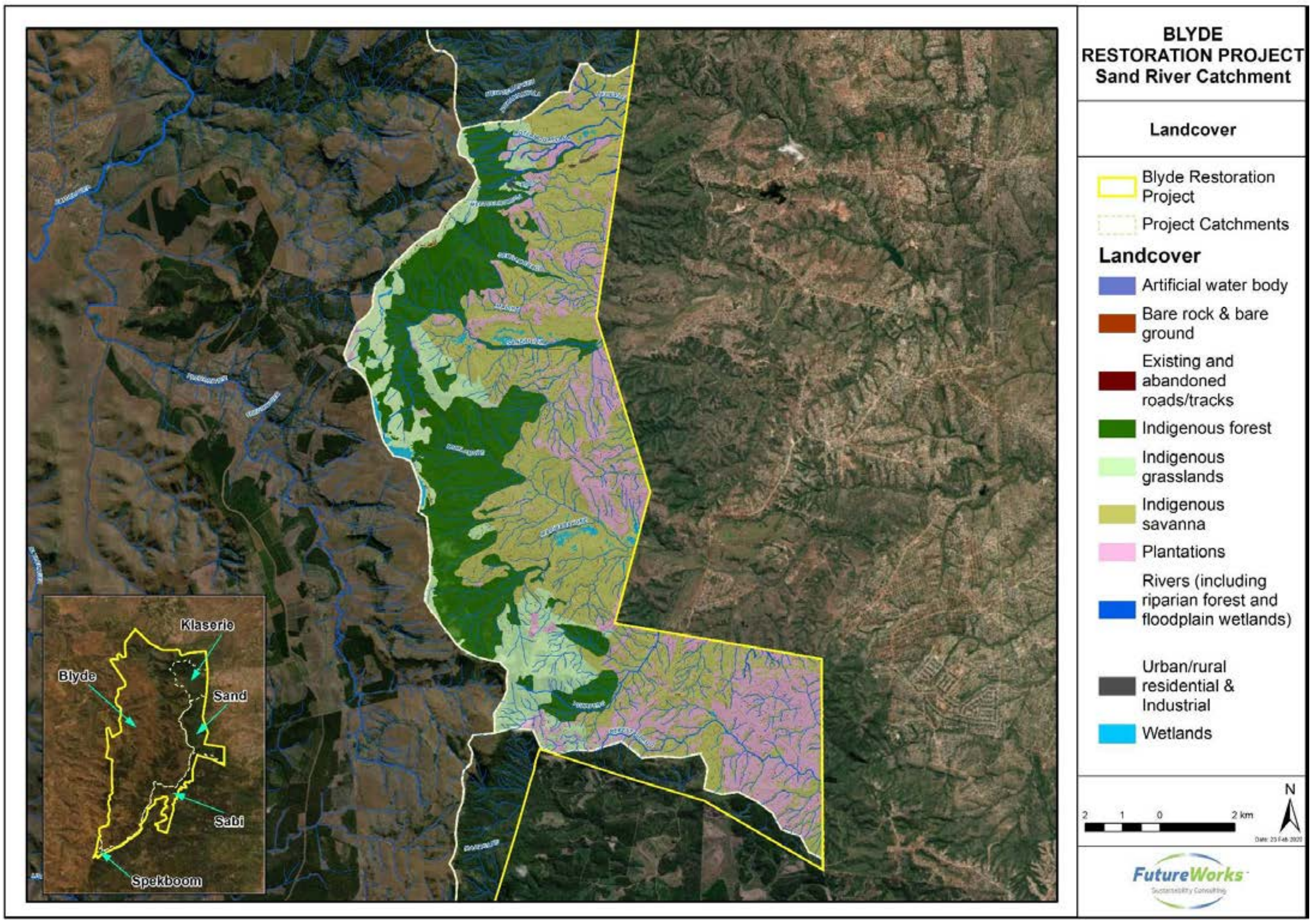

Figure 2: Landcover types of the Upper Sand Catchment within the DEFF Forestry Lowveld Plantations. The location of the Upper Sand Catchment in relation to the Blyde, Klaserie and Sabie Catchments is shown in the cut-out map.

The key landcover categories are:

Artificial water bodies	Existing and abandoned roads/tracks	Indigenous grassland
Indigenous forest	Plantations	Urban/rural residential & Industrial
Rivers (including riparian forest and floodplain wetlands)	Indigenous savanna	Wetlands

The total area mapped was 11 059 hectares, and the relative sizes of the landcover types are illustrated in Figure 3. Note that assets such plantations also host and support ecological and hydrological processes (beyond timber production) which benefit society, such as soil stability and flood risk reduction, and are therefore included in the ecosystem services analysis.

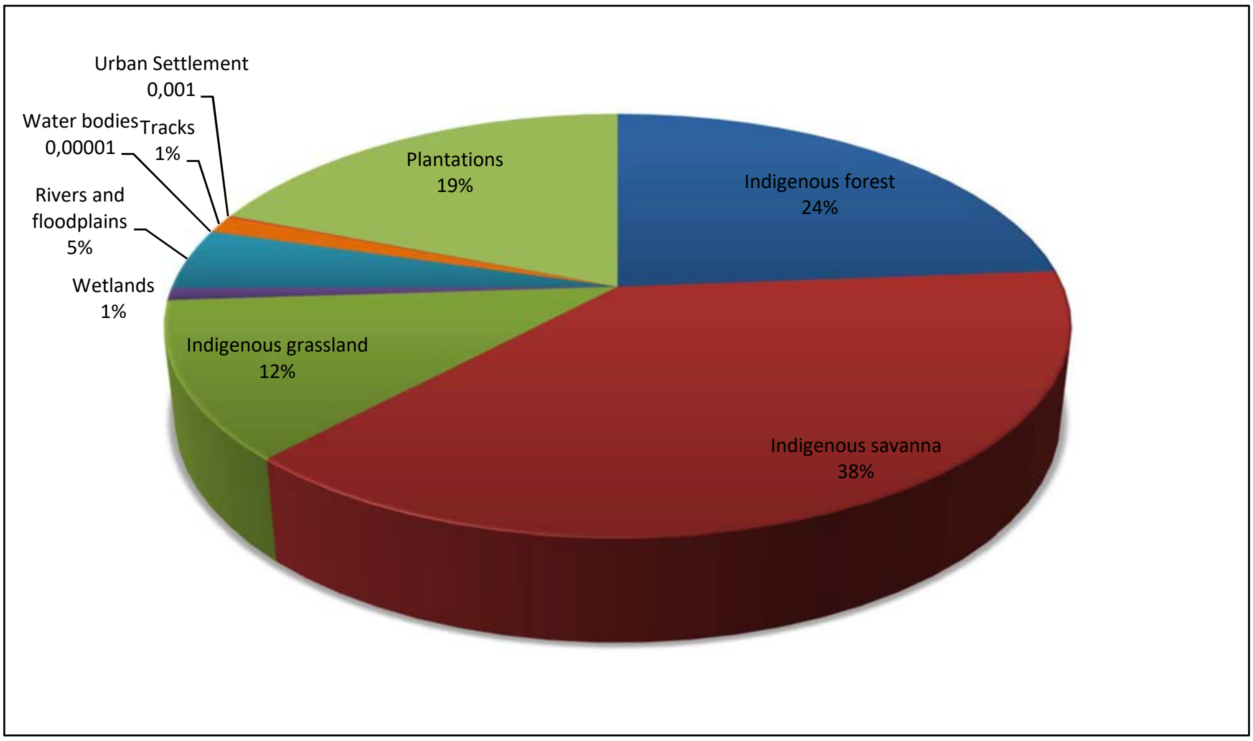

Figure 3: The relative size of the landscape assets.

The landcover types listed above, generate a suite of ecosystem services which are used directly or indirectly by humans. The bigger and better the condition of the ecosystem or landcover types, the greater the level of services supplied.

The following ecosystem services were analysed in the workshop:

Fibre timber and thatch for construction	Fuel wood - for energy	Fodder - grazing for stock or wildlife	Food crops - food for consumption or processing
Pollination - of fruit and legume crops	Soil formation and fertility - for agriculture	Soil stability - for production or sedimentation avoidance	Surface water supply - for abstraction
Dry season flows - for dry season water security	Waste assimilation and dilution - for water quality maintenance	Medicinal plant products - for traditional healing	Hunting & fishing - recreational hunting and fishing
Cultural heritage - for cultural appreciation	Fire damage control - for fire risk reduction	Flood damage control - for flood risk reduction	Carbon storage & sequestration - for carbon offsets trading
Biodiversity conservation targets - for meeting government targets	Refuge, nursery or corridor - for replenishing fishing or hunting stocks	Transport access - for accessing areas or services	Education & research - a laboratory for students and pupils
	Adventure recreation - sites for recreation		

6.2 The future landcover and land-management scenarios

A series of future scenarios were developed by the workshop participants to analyse changes to ecosystem services and associated human benefits (see Figure 4), and included a 'do nothing' scenario, a 'maximise private benefits' scenario and a 'win-win' scenario. In these scenarios, different land uses and possible land-management and governance were developed, and any possible associated impacts extrapolated, resulting in associated changes to the size (in hectares) and condition (scores) of existing landscape assets.

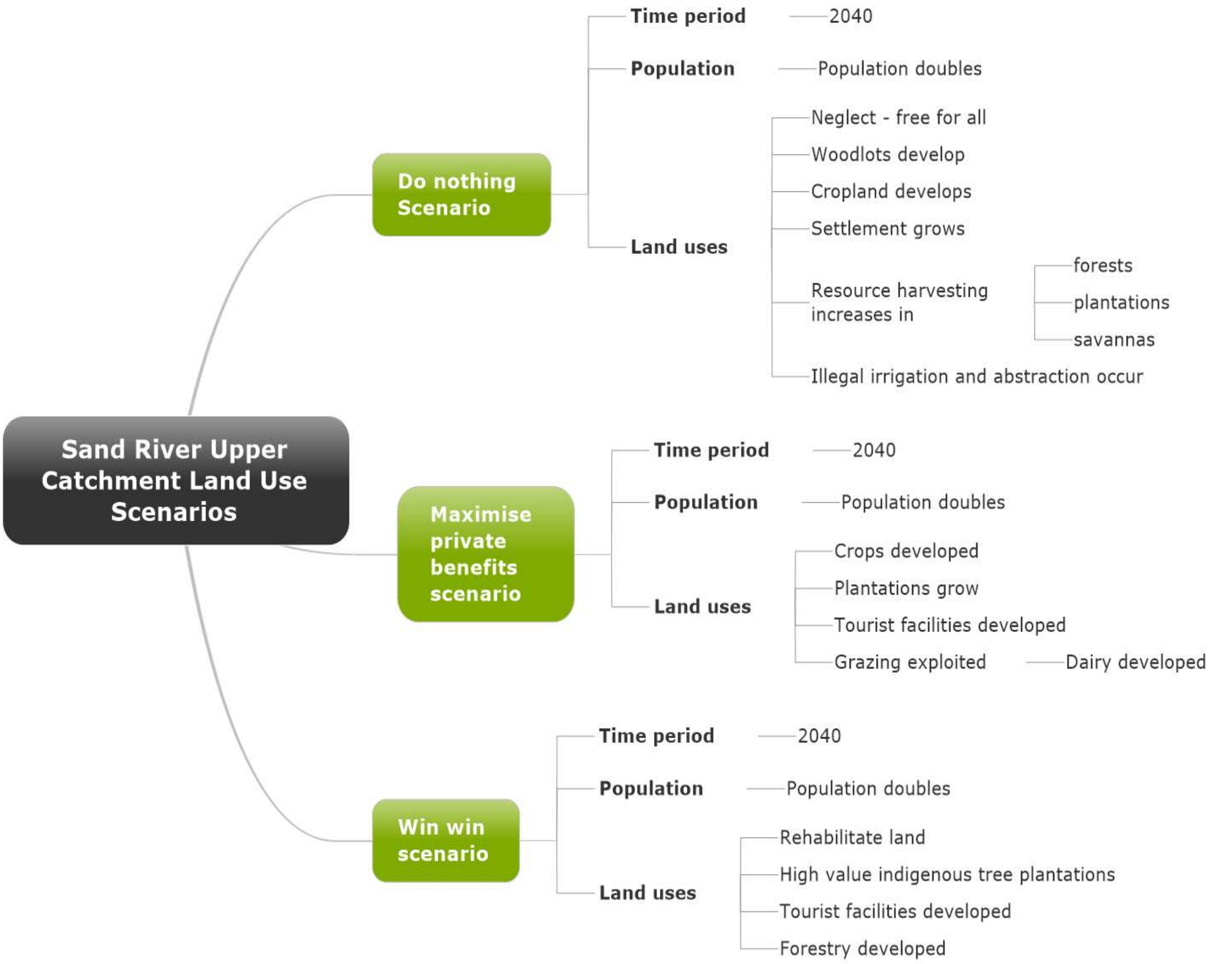

Figure 4: Scenarios for the Upper Sand River

To start with the modelling required an understanding of the current (or baseline) functionality of the land cover types, which required an analysis of the condition of the assets together with their size. Figure 5 illustrates the status quo condition of the assets largely resulting from the management of these land-cover types within the Lowveld Plantations over the past 10-15 years (along with some historical impacts such as the spread of IAPs).

Areas were calculated using GIS, while condition scores were generated in the workshop with stakeholders. Condition scores relate to a baseline condition which in natural areas would be a pristine and well-functioning state and would score a 4, and in transformed areas the score would relate to 'industry sustainable best practice', for example, in croplands organic farming would be the best and score a 4.

In addition, the plausible population growth (given published trends and local knowledge) was discussed and then land use responses to population trends was explored, with the possible changes in land cover type, size and condition proposed and inserted into the systems model. Importantly, the land area was always kept constant (11 059 ha), so any increase in, for example, in plantations would require a concomitant reduction in another land asset, such as woodlands or riparian forest.

Note that scenarios were modelled to included linkages between habitat types. For example, when wetlands were negatively impacted, the downstream river condition would decline accordingly. See Table 2 for the land cover types' condition and size in the status quo and in the three alternative scenarios.

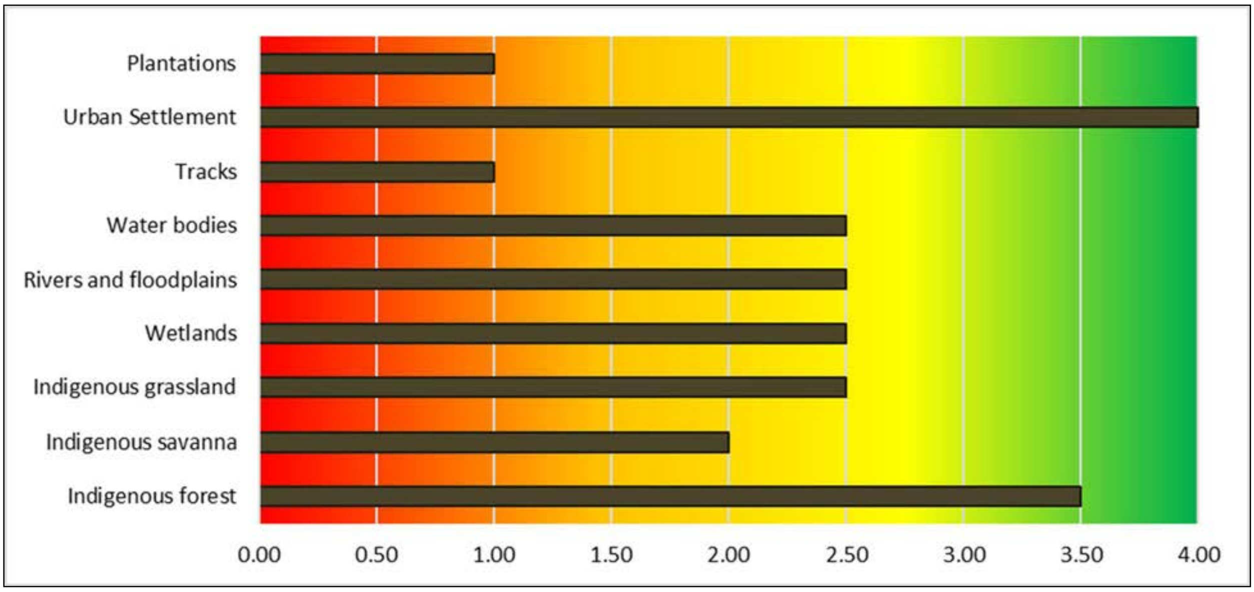

Figure 5: The condition or state of the land cover types
(4=100% pristine conditions or industry best sustainable practice)

TABLE 2: LAND COVER TYPES SHOWING EXISTING AND POSSIBLE FUTURE CONDITIONS AND SIZE FOR THE AFFECTED AREA
(Condition scores relate to pristine (for natural areas) and industry best sustainable practice (for transformed landscapes):
1=<25%, 2=25-50%, 3=50-75%, 4=>75%; hectares are measured)

Status-Quo

ECOLOGICAL ASSETS	Indigenous forest	Indigenous savanna	Indigenous grassland	Wetlands	Rivers and floodplains	Water bodies	Tracks	Urban Settlement	Plantations	Secondary forest	Croplands
CONDITION - score relative to its potential - 4 to 0	3.50	2.00	2.50	2.50	2.50	2.50	1.00	4.00	1.00	2.00	0.00
SIZE - area in ha (rivers in km)	2628.0	4222.0	1329.0	105.0	515.0	0.1	148.5	11.9	2099.0	0.0	0.0
Percentage of total	23.8%	38.2%	12.0%	0.9%	4.7%	0.0%	1.3%	0.1%	19.0%	0.0%	0.0%
OVERALL FUNCTIONALITY	12,877	10,133	4,319	341	1,674	0	193	66	2,939	-	-

S 1 - Do nothing

ECOLOGICAL ASSETS	Indigenous forest	Indigenous savanna	Indigenous grassland	Wetlands	Rivers and floodplains	Water bodies	Tracks	Urban Settlement	Plantations	Secondary forest	Croplands
CONDITION - score relative to its potential	1.00	1.50	1.00	1.00	1.00	1.00	1.00	1.00	0.50	1.00	1.50
SIZE - area in ha (rivers in km)	1628.0	4182.0	329.0	55.0	365.0	0.1	148.5	51.9	2099.0	2000.0	200.0
Percentage of total	14.7%	37.8%	3.0%	0.5%	3.3%	0.0%	1.3%	0.5%	19.0%	18.1%	1.8%
OVERALL FUNCTIONALITY	2,279	7,528	428	72	475	0	193	73	1,469	2,400	300

S 2 - Maxi private benefits

ECOLOGICAL ASSETS	Indigenous forest	Indigenous savanna	Indigenous grassland	Wetlands	Rivers and floodplains	Water bodies	Tracks	Urban Settlement	Plantations	Secondary forest	Croplands
CONDITION - score relative to its potential	3.50	2.50	2.50	1.00	1.00	2.00	2.50	3.00	3.00	1.00	3.00
SIZE - area in ha (rivers in km)	2628.0	972.0	1129.0	55.0	305.0	10.0	148.5	111.9	4599.0	100.0	1000.0
Percentage of total	23.8%	8.8%	10.2%	0.5%	2.8%	0.1%	1.3%	1.0%	41.6%	0.9%	9.0%
OVERALL FUNCTIONALITY	12,877	2,916	3,669	72	397	26	446	470	19,316	120	3,000

S 3 - Win Win

ECOLOGICAL ASSETS	Indigenous forest	Indigenous savanna	Indigenous grassland	Wetlands	Rivers and floodplains	Water bodies	Tracks	Urban Settlement	Plantations	Secondary forest	Croplands
CONDITION - score relative to its potential	3.50	3.00	3.00	3.00	3.00	2.50	3.00	4.00	3.00	2.50	3.00
SIZE - area in ha (rivers in km)	2628.0	3712.0	1329.0	105.0	515.0	0.1	78.5	21.9	2099.0	70.0	500.0
Percentage of total	23.8%	33.6%	12.0%	0.9%	4.7%	0.0%	0.7%	0.2%	19.0%	0.6%	4.5%
OVERALL FUNCTIONALITY	12,877	13,363	5,183	410	2,009	0	306	122	8,816	210	1,500

6.3 The magnitude and location of current services supplied

The ECOFUTURES model combined the land cover types' functionality (an indicator from the product of condition x size x connectivity) with the land cover's potential capability to produce ecosystem services (in ideal conditions), to predict relative service levels (e.g. service a supply level = ((habitat y area x condition score) x connectivity) x service supply capability score). A look-up table of service supply capability scores (again using a 1 to 4-point score – with 4=high, 3=medium high, 2=medium low and 1=low capability) was proposed by the consulting team and adapted by the workshop participants.

Figure 6 shows the relative magnitude of the different ecosystem service levels for the affected area at the current time (February 2020). These levels are an index or indicator only. Note the highs (biodiversity conservation targets, adventure recreation and carbon storage) and lows (transport access, surface water supply and food crops).

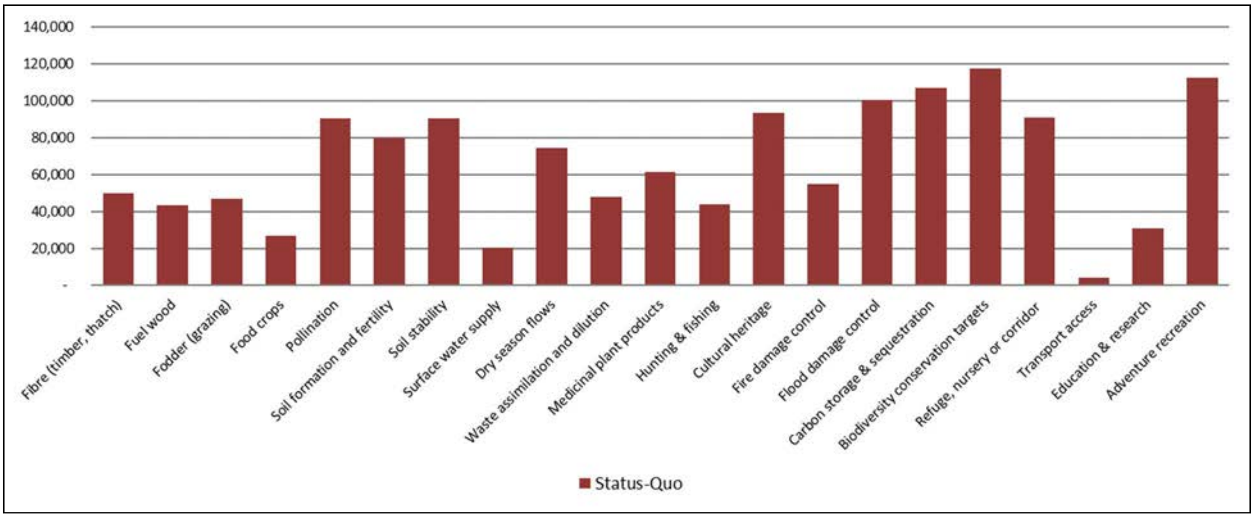

Figure 6: Relative ecosystem service levels in the catchment
(the units are an index with the highest being relatively most abundant and the lowest being relatively least abundant)

Figure 8 shows which land cover types are generating the greatest levels of services in total (based on total area of land cover) (the blue column) and the greatest services supply per hectare (the red line). This graphic illustrates that land cover such as the indigenous forest and savanna are currently generating the greatest volume of services. It also shows that indigenous forest and rivers (and floodplains) generate the greatest service levels per hectare. These two factors highlight which land cover types, in general, show the maintenance priorities, and which land cover types offer the greatest benefits per hectare when restored.

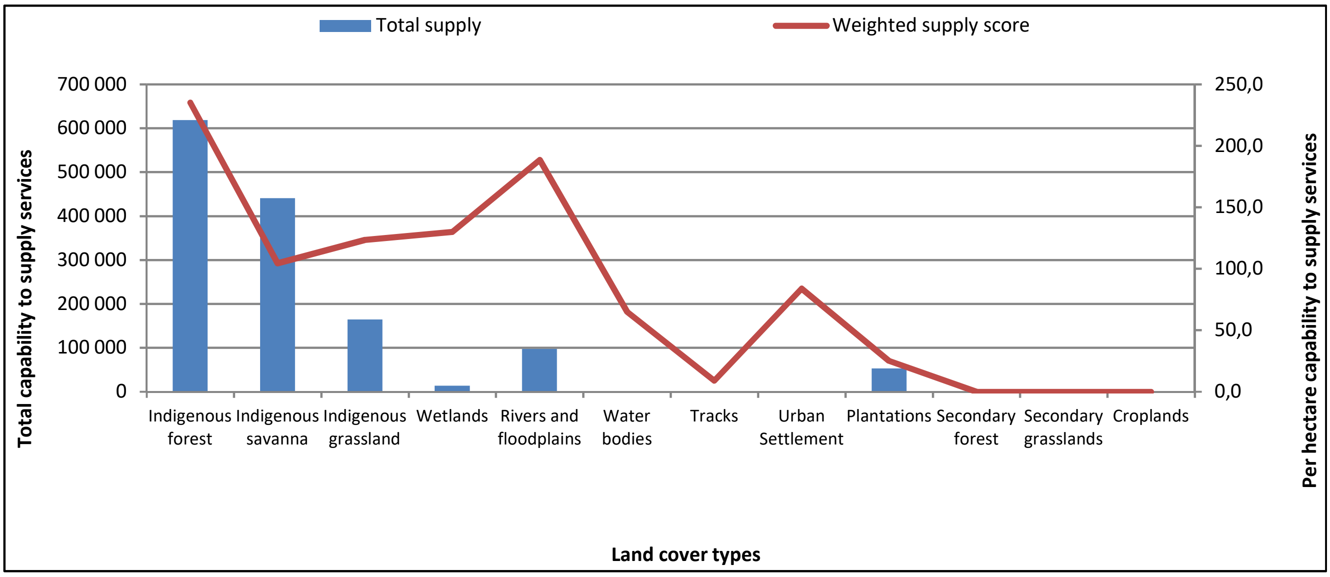

Figure 7: The supply of services per land cover type in the affected area - the total supply is the sum of all services for total area of a single land cover type (the column), while the per hectare capability is the average supply per hectare (total supply per land cover divided by total area of a land cover)

On the other hand, Figure 7 shows the relative contribution of each land cover type to the supply of specific ecosystem services. For example, fodder is supplied predominantly by indigenous savanna, fire damage control is supplied predominantly by indigenous forest and surface water supply is produced largely by rivers. This graphic can assist in prioritising land cover management actions depending on the services or human vulnerability the local managers (such as CPAs, MTPA or DEFF Forestry & NRM) may be focussing on.

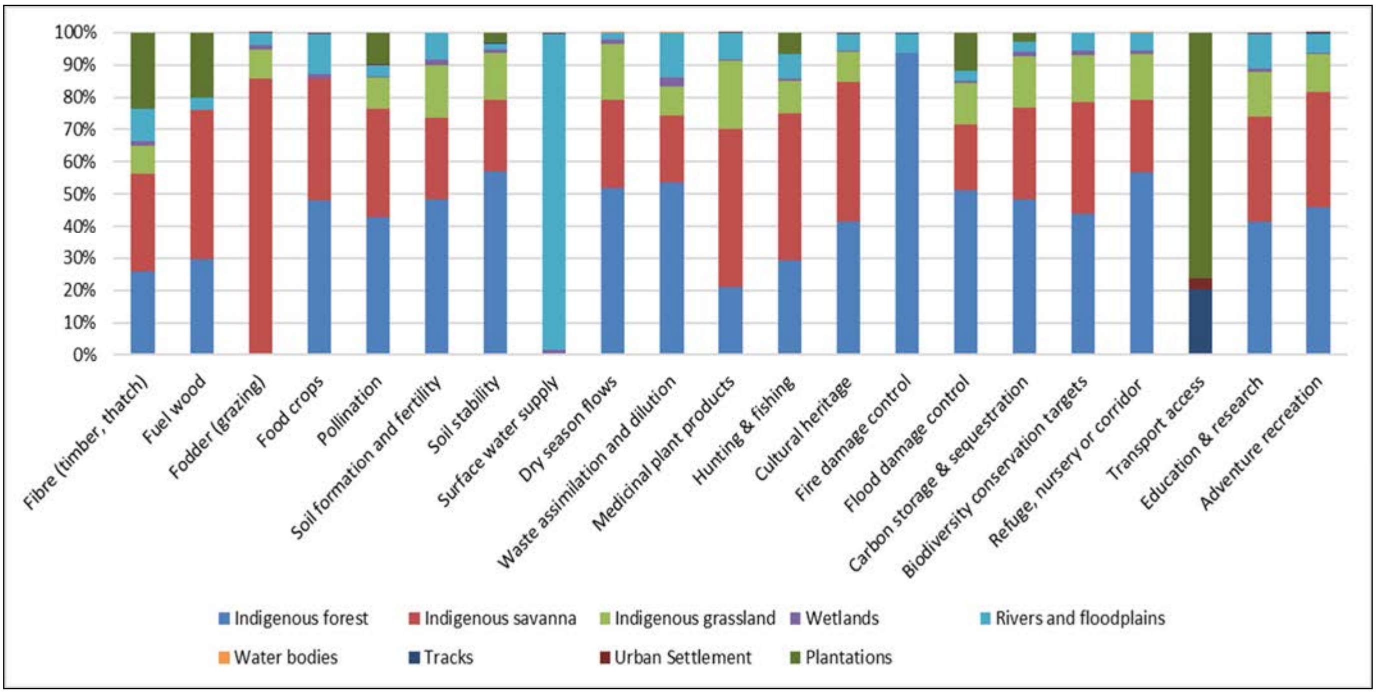

Figure 8: The relative contribution of landcover types to the total quantity of a specific service supplied in the affected area

The location of the land cover types and services they supply are illustrated in Figure 9.

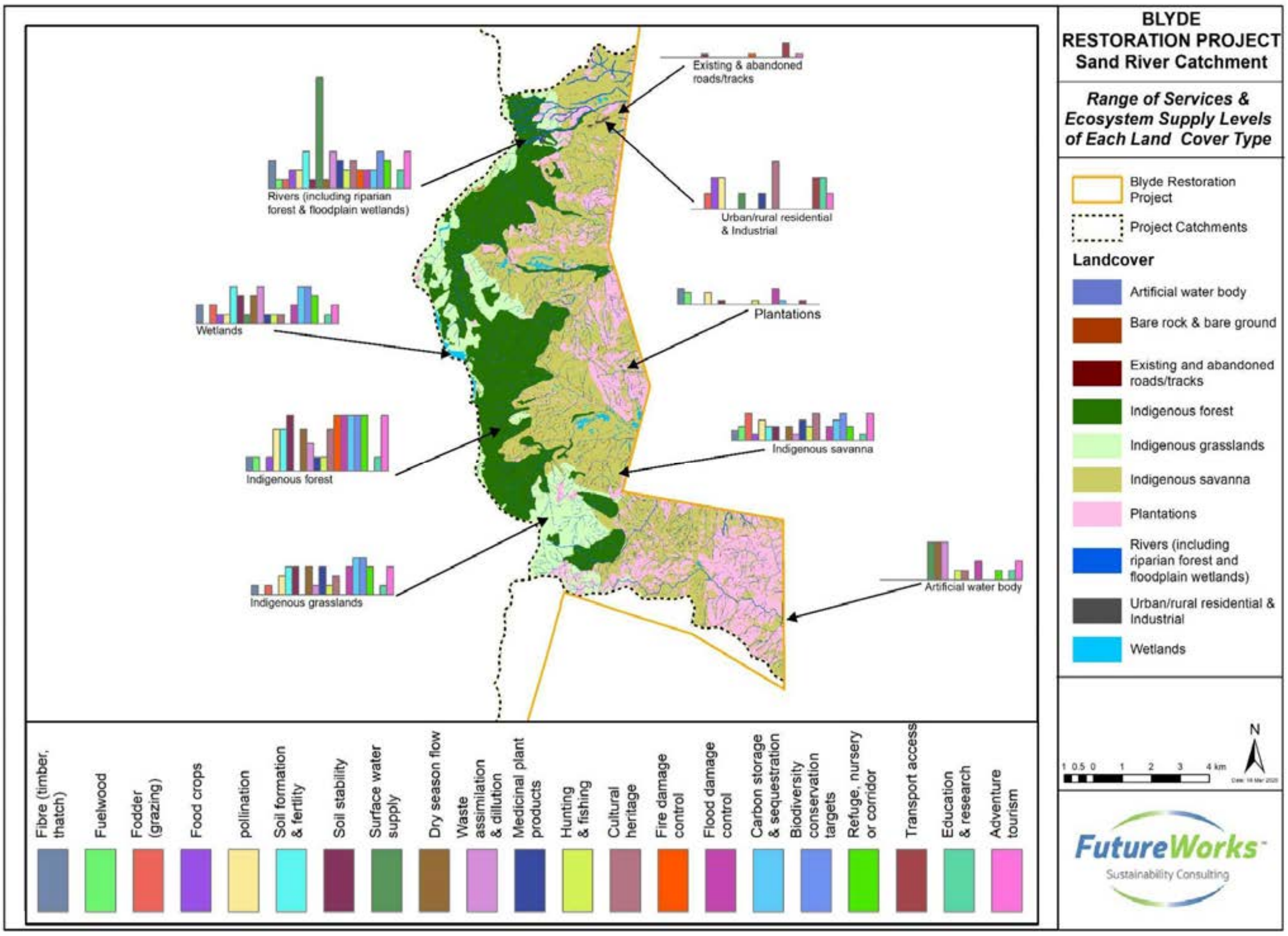

Figure 9: The location of land cover types in the Upper Sand River Catchment, showing the relative service supply capabilities

6.4 Changes to services supply in different scenarios

In Figure 10 the red line constitutes the current supply level (with each service depicted as 100% of current supply levels). The percentage change in different scenarios is reflected by the different scenario lines. In the 'do nothing' scenario, there is a serious decline in all services, and warns against a future where on-going ownership transfer delays will lead to serious wellbeing losses for society.

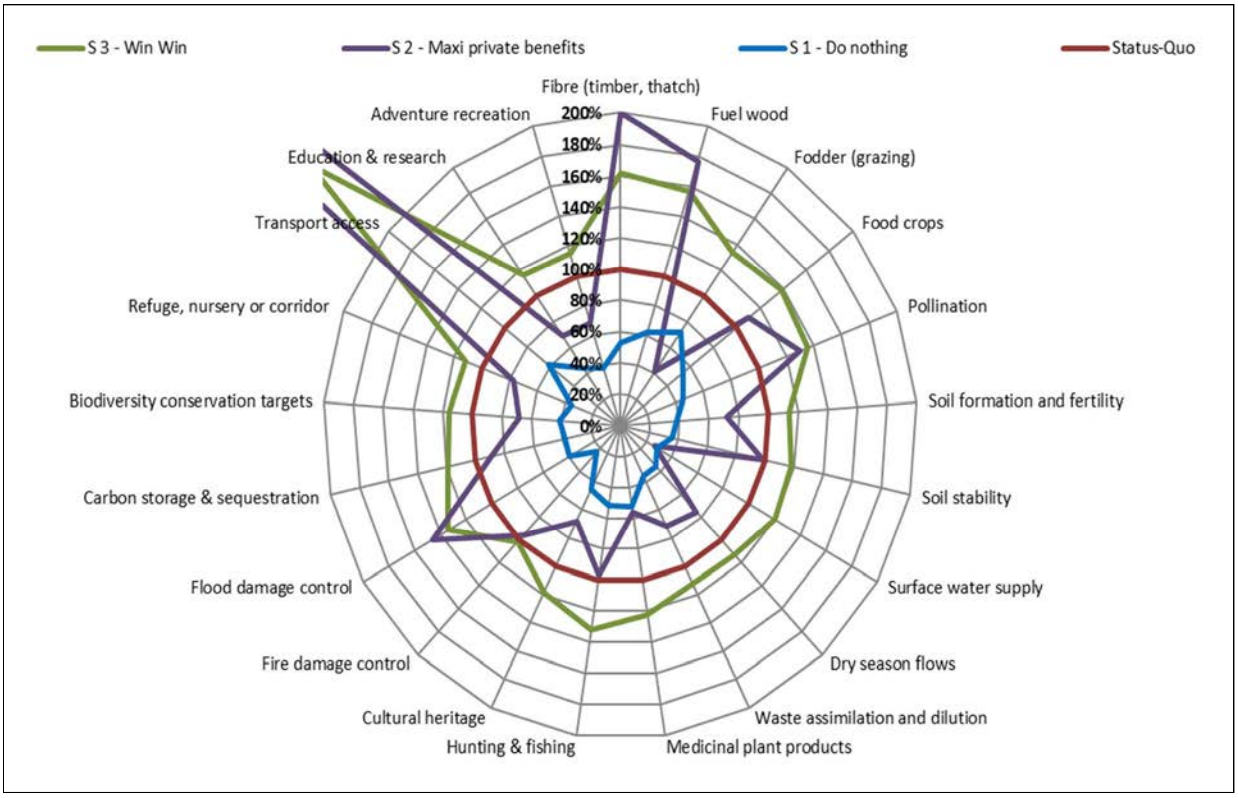

Figure 10: Changes in the supply of ecosystem services in different scenarios in the affected area (the red line shows supply at 100% of current levels)

Note that for the 'maximise private benefits' scenario selected services such as fibre, fuelwood, food crops, pollination, flood damage control and transport access – all increase significantly, given the possible growth in plantations and food crops. On the other hand, this scenario also generates a reduction in key public service benefits such as surface water supply, dry season flows and conservation targets.

The 'win-win' scenario, which includes some plantation forestry, agriculture development and tourism, results in a significant growth in public and private benefits. The 'win-win' scenario offers both public and private benefits and is clearly the societal optimal option.

7 The demand for services

In considering the changes in services supply, the question that begs answering is – how significant are these changes to human welfare? To answer this question, the ECOFUTURES process captures the numbers of services users and their relative dependence on these services, and generates an index, the human benefit index[2], so that the trade-offs between choices can be compared. A human benefit index is used as people may benefit very differently from services. For example, as plantation forestry grows and/or increases in efficiency, the owners of plantations benefit with increased fibre and fuelwood trade. However, downstream ecosystem services, such as dry season flows and water abstraction decline for a different suite of users. In developing an understanding of the number and dependence on ecosystem services, the following sources were used to inform the discussion which determined the estimated numbers and the level of dependence:

- STATSSA population estimates for provincial and local municipalities;
- Eskom household database (2009) – see Figure 11 showing the location of homesteads relative to the Sand River;
- Expertise within AWARD and K2C, and
- Local resource consumers or other stakeholders participating in the workshop.

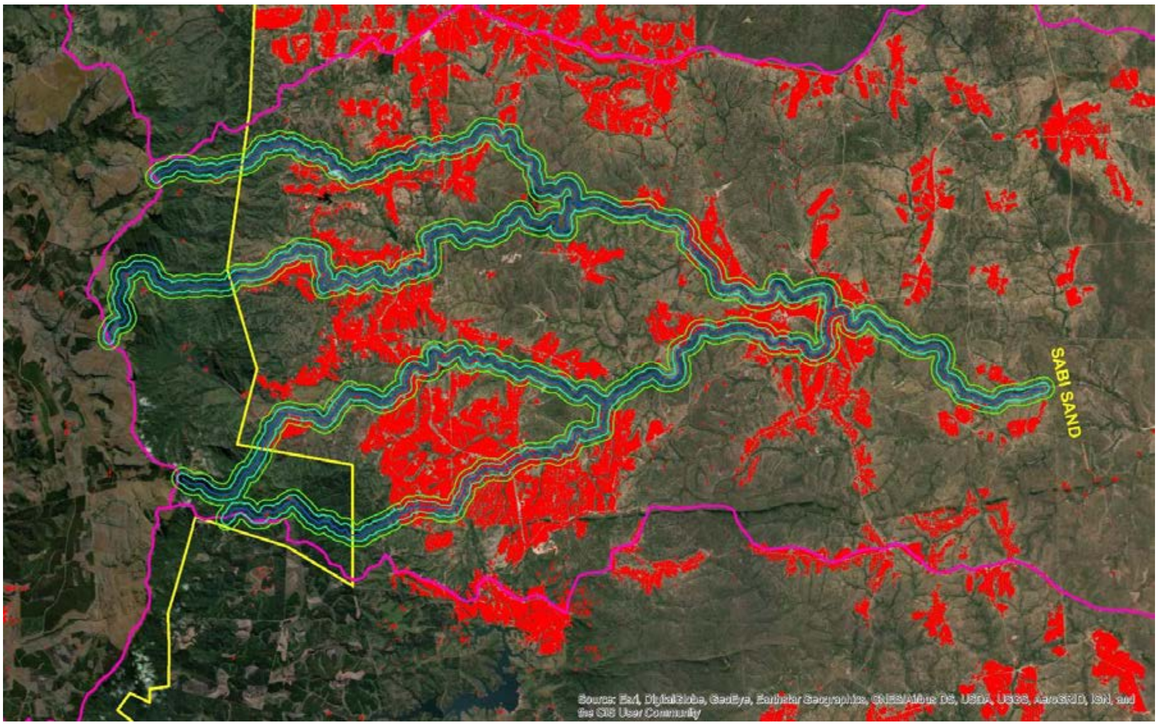

Figure 11: The location of homesteads (red dots) relative to the Sand River and its main perennial tributaries, with a 250 buffer (turquoise line) and 500m buffer (yellow line) shown, up to the Sabi-Sand Wildtuin boundary

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[2] *The human benefit index is calculated by multiplying the number of users by their respective levels of dependency. Note the following weighting is used in scoring the relative dependence, with very high dependence = 1, high dependence = 0.5, moderate dependence = 0.1, and low dependence = 0.01. Very high is lifesaving or a critical component of household income. For example, 100 users x critical dependency (1 weighting) = 100 Human Benefit Index. On the other hand, 100 moderately dependent users would be 100 users x moderate dependency (0.1 weighting) = 10 Human Benefit Index. See Cartwright, A., Blignaut, J., De Wit, M., Goldberg, K., Mander, M., O'Donoghue, S. and Roberts, D. 2013. Economics of climate change adaptation at the local scale under conditions of uncertainty and resource constraints: the case of Durban, South Africa. Environment and Urbanization published online 6 March 2013.*

The levels of demand are outlined in Figure 12. The height of the graph indicates the Human Benefit Index, while the colours signify the relative levels of dependence. Note that the biodiversity conservation target has the highest index (450 000 Human Benefit Index) but the graph's vertical axis is limited to 120 000 units to permit analysis of the lower scores. The second highest index is 115 000 for surface water supply and includes local households abstracting water (either fulltime or due to reticulated supply breakdowns), cattle owners, game reserve owners and users, and downstream irrigators. The high surface water supply score is due to the Sand River contributing to provincial and Maputo users. However, note the low dependence for many users as the Sand River will only make a small contribution to the Maputo supply. The third highest index is the dry season flow users, and these users show a very high level of dependence on the services. In other words, there are few alternative supply options for dry season flows, and significant welfare losses will occur if access to dry season flows decline. For example, if cattle owners, water users augmenting reticulation breakdowns and game farms, cannot access dry season flows then they will experience serious hardships (health or income).

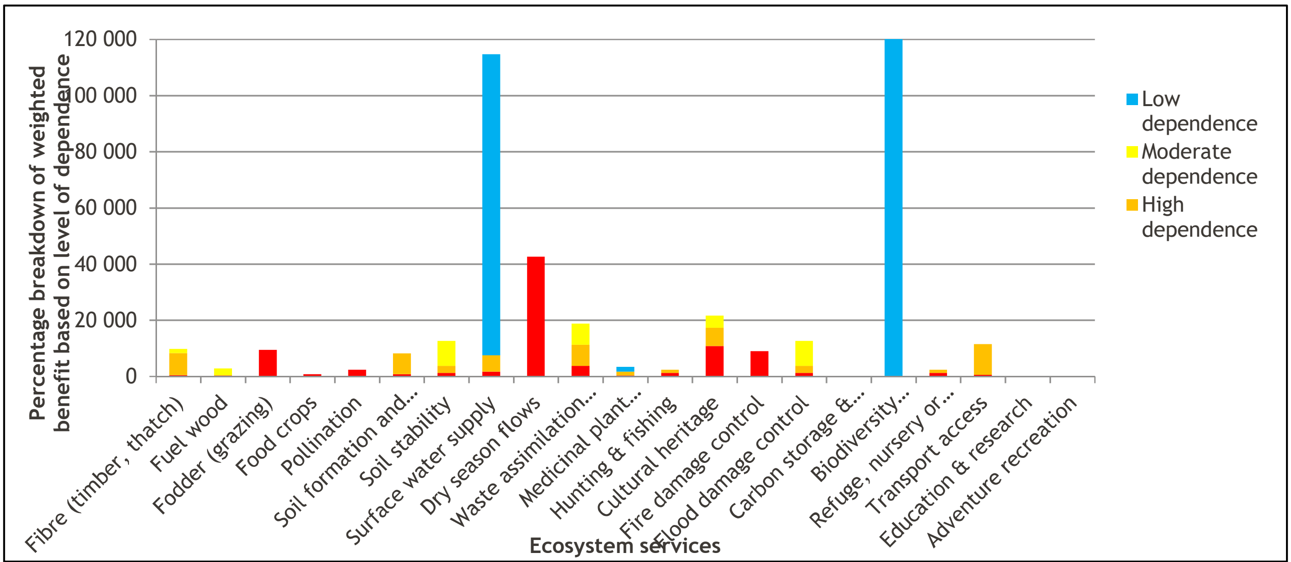

Figure 12: The human benefit index in terms of the product of estimated user numbers and the relative dependence on ecosystem services

It is important to note that numerous other services, such as fodder, pollination, cultural heritage, fire damage, waste assimilation and dilution (water quality), fire and flood damage control, fibre and road access (to plantations) – all have high importance to the current users, even if their numbers are smaller than the water supply users.

The affected area plays a role at the provincial and international level by helping meet conservation targets and water supply requirements (but the Upper Sand is not sole supplier). The Upper Sand plays a key role at the local level in meeting basic needs, such as dry season assurance of water supply, cultural heritage, water quality maintenance, soil stability, flood damage control, fodder and fibre.

The demand for services (using the human benefit index as a proxy) helps prioritise which services to focus on, and therefore what supporting natural capital to prioritise for management. The demand for services also shows which user groups could be engaged in order to access resources or political support for effectively managing the area. For example, engage with provincial authorities to garner support for forest conservation, and engage with local authorities to get support for downstream water security maintenance. Furthermore, commercial products like fibre (timber), indicate that timber companies should be engaged.

8 The risks to services use

Comparing ecosystem services supply and demand levels provides an indication of the risks associated with each service. See Figure 13. In this analysis, risk is measured by dividing demand by supply, in other words, how much supply is there per user, and how might this change in different future scenarios. The very large numbers of provincial and Maputo users dominate the analysis and show that only the win-win scenario will be able to moderate risk significantly.

The transport access risk is high as there are many users for the limited road network.

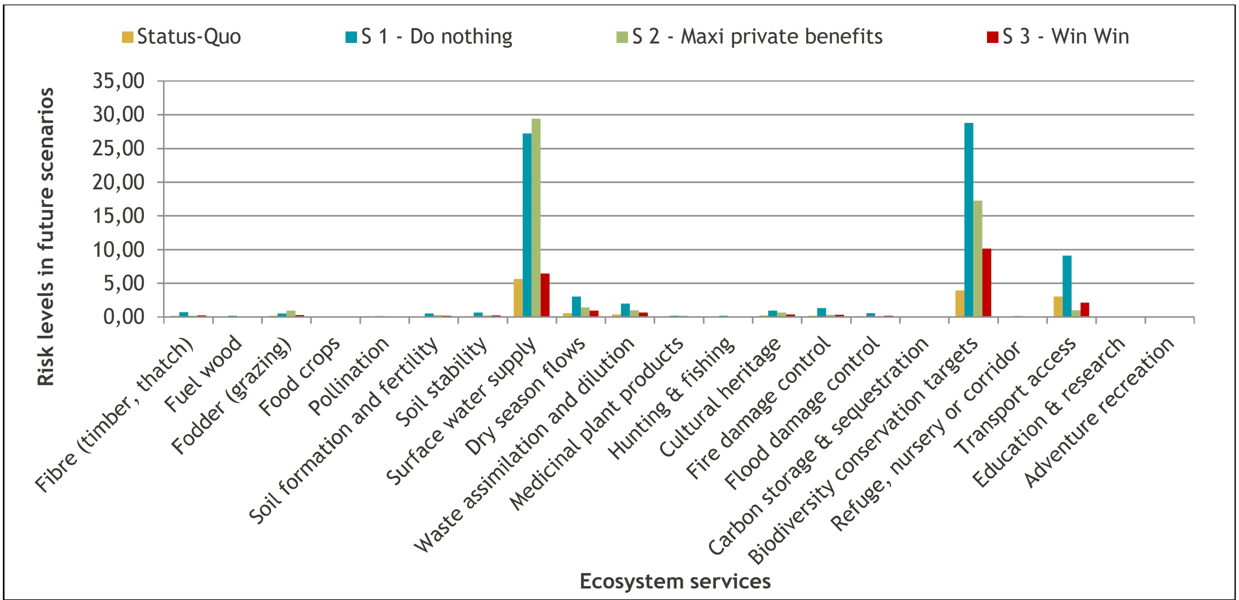

Figure 13: The risk profile of services supply in the current and future scenarios in the affected area

To show the local implications for risk, the vertical axis is limited to 4 risk index units – see Figure 14. This shows how the risks to dry season flows, waste assimilation and dilution (water quality maintenance), fire damage control and flood damage control would significantly increase in a neglect scenario and would be moderated by a win-win scenario.

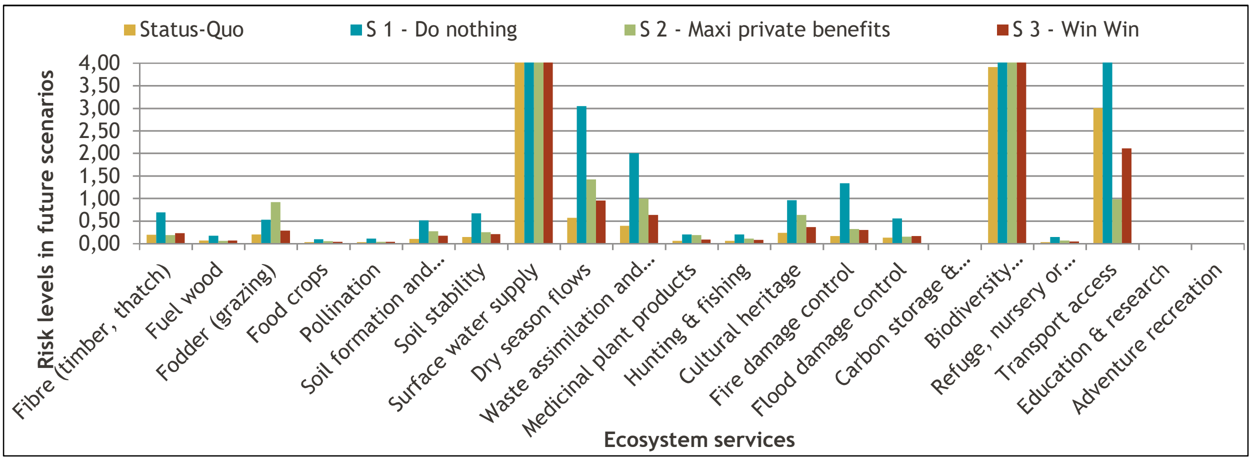

Figure 14: The risk profile of local services supply in the current and future scenarios in the affected area (axis constrained)

9 Main conclusions

The Upper Sand Catchment with its history of indigenous forest protection and afforestation consists of both natural and transformed landcover types. Based on participants' knowledge of the area some landcover or habitat types such as indigenous forests were judged to be in relatively good condition currently, while others such as plantations and savannas are in poor condition. The area supplies a wide range of ecosystem goods and services, however current perceived trends indicate that the longer term supply of these services is not certain. A 'do nothing' scenario with further decline in the management and governance of different land-uses with concomitant decreases in ecosystem or landcover conditions will lead to a serious decline in all services. This highlights the need for a range of land management interventions and attention to key governance aspects in relation to these.

The demand for services is diverse, with CPA development aspirations, neighbouring community needs, downstream water demands, provincial commitments and even international needs (Maputo City water users). A 'win-win' scenario comprising a balanced suite of sustainable land uses, associated restoration and improved land management, in line with the current decisions around future land-use (conservation and some forestry) has the potential to meet both CPA needs and local societal needs (given increased population) effectively.

There are high levels of dependence on a number of services originating in the Upper Sand River Catchment and any land-use in the area needs to take these into consideration. The supply of services and therefore user benefits, are at risk in 'do nothing' and 'maximise private benefits' scenarios. Key service user stakeholder groups should be engaged to garner resources and support for avoiding the 'do nothing' scenario.

10 Way forward

The above process presents a first step towards developing a participatory and collective understanding of the ecosystems services originating from the Upper Sand Catchment, as well as the outcomes under various potential future land-use and land management scenarios. Various aspects of the process both in terms of the technical procedures as well as in terms of the involvement of stakeholders can still be improved. Nonetheless the assessment has highlighted a number of key things. First the benefits of improved ecosystem condition or health through restoration of natural landcover types and their subsequent sustainable use through low-impact land-uses along with the improved management of more intensive land-uses such as forestry, could significantly increase a number of ecosystem services. The assessment has further highlighted that a large number of different of land-use activities benefitting a broad set of stakeholders is possible, which would allow more equitable benefit sharing amongst different stakeholder groups. This would require a number of tenure arrangements amongst the various stakeholder groups enabling governance of various land-use activities though.

The results from this assessment will be used to inform the catchment restoration strategy being developed, and particularly the prioritization within the Integrated Restoration plan being developed for the expanded Blyde River Canyon Nature Reserve (as part of the new Integrated Management Plan developed by the K2C, MTPA and partners). The results will also provide valuable information for the further development of the visioning process being carried out with the Blyde CPAs and further key stakeholders in partnership with the K2C. Current funding limitations has constrained expanding this process to the Blyde and Klaserie Catchments, but various opportunities will be explored during 2020 to try and secure this.

AWARD

The Association for Water and Rural Development

AWARD is a non-profit organisation specialising in participatory, research-based project implementation. Their work addresses issues of sustainability, inequity and poverty by building natural-resource management competence and supporting sustainable livelihoods. One of their current projects, supported by USAID, focuses on the Olifants River and the way in which people living in South Africa and Mozambique depend on the Olifants and its contributing waterways. It aims to improve water security and resource management in support of the healthy ecosystems to sustain livelihoods and resilient economic development in the catchment.

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About USAID: RESILIM-O

USAID: RESILIM-O focuses on the Olifants River Basin and the way in which people living in South Africa and Mozambique depend on the Olifants and its contributing waterways. It aims to improve water security and resource management in support of the healthy ecosystems that support livelihoods and resilient economic development in the catchment. The 5-year programme, involving the South African and Mozambican portions of the Olifants catchment, is being implemented by the Association for Water and Rural Development (AWARD) and is funded by USAID Southern Africa.

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