CHAPTER 2

Ecology, Biodiversity and Conservation Planning

CHAPTER 2: Ecology, Biodiversity and Conservation Planning

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The view looking south from the top of Boegoeberg in 1994, a time before the great sand mobilisation and when there was still veld in this landscape. (photograph: Philip Desmet)

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Executive Summary

This report forms part of Work Package 2 for the Boegoebaai Strategic Environmental Assessment (SEA), focusing on regional biodiversity sensitivities and risks in the Namakwa Region, Northern Cape, South Africa. It integrates spatial biodiversity planning informants to guide development scenarios, particularly in relation to the emerging green hydrogen (GH2) economy.

The Namakwa Region study area covers approximately 5.75 million ha, including the Kamiesberg, Khai-Ma, Nama Khoi, and Richtersveld Local Municipalities. This is a landscape comprising coastal plains, escarpment mountains, sand-covered Bushmanland plains, and the Orange River valley, straddling a key biogeographic boundary between winter and summer rainfall zones and most significantly is the centre of the Succulent Karoo Biome.

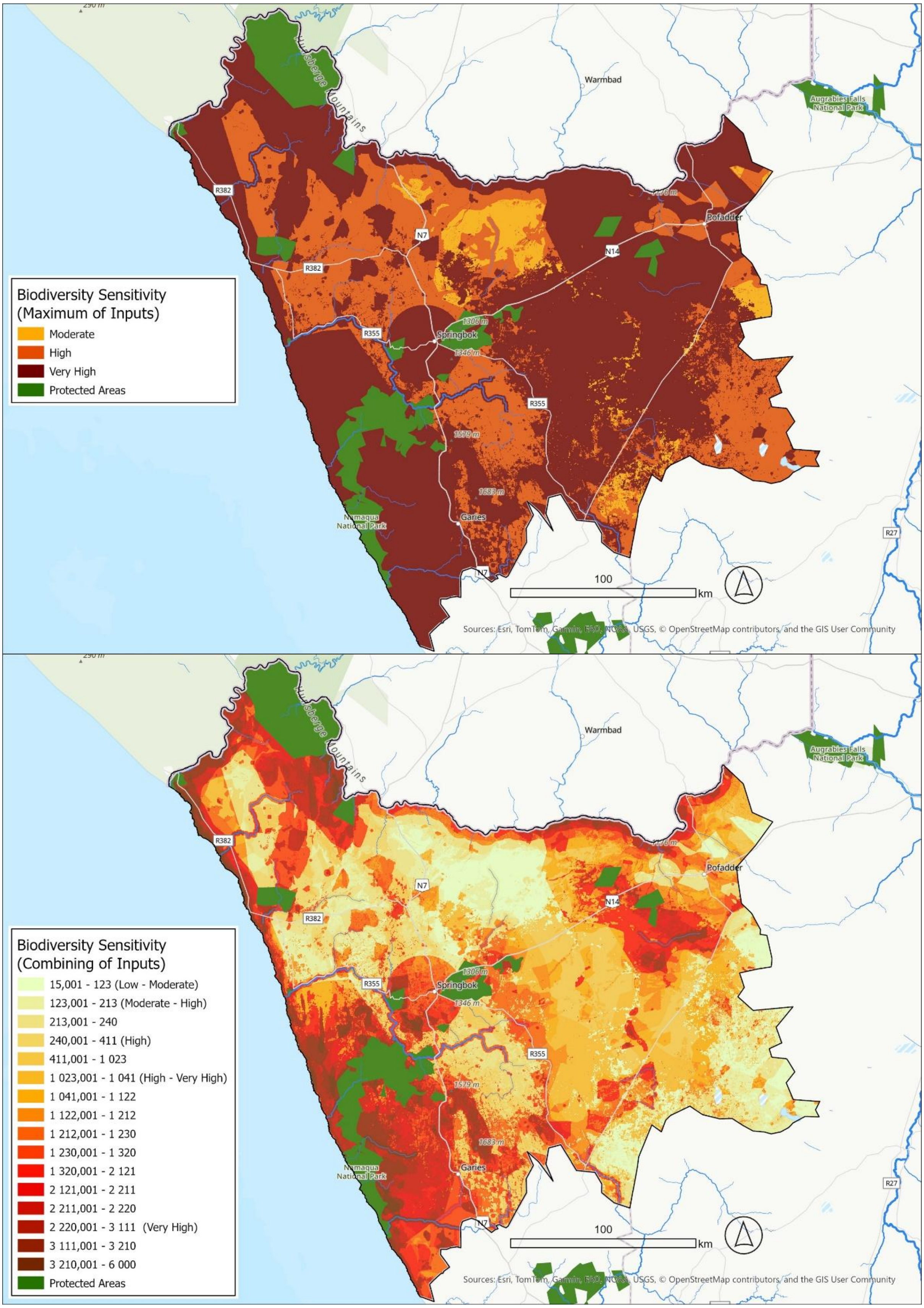
The region is a global biodiversity hotspot. The Succulent Karoo Biome is the world's most species-diverse arid region, with exceptional levels of plant endemism and diversity. This biodiversity is unevenly distributed, with local hotspots being especially sensitive. Key habitats for biodiversity include gravel patches, quartzite mountains, south-facing slopes, high plateaus, and relic ecosystems (fynbos, renosterveld).

Current threats to the region include livestock grazing (most widespread, reversible if managed), mining (current and future, especially mineral sands), renewable energy (solar and wind farms), linear infrastructure (transmission lines) and poaching of plants and animals for the collectors' trade (real-time species extinction risk).

Climate Change is possible the most significant current threat. The region is experiencing significant ecosystem degradation, with desert biome expansion predicted by 2070. Vegetation productivity trends show widespread browning, especially in the Richtersveld. Based on an analysis of EVI trends and the levels of degradation quantified indicates that at least 65% of the regions 71 vegetation types can be considered as threatened ecosystems in terms of Red List of Ecosystems (RLE) criterion D1.

Protected Areas: Currently, less than 8% of the region is formally protected, with efforts underway to expand this to 30% by 2030. At least 70% of the region is currently earmarked by one or more protected area expansion plan. In terms of Ecosystem Protection Levels (EPL) only 28% of ecosystems are well protected; 66% are poorly or not protected. There is still a significant amount of work required to reach the 30x30 targets.

The biodiversity sensitivity analysis combines available biodiversity informants (into a single 4-class high-low biodiversity sensitivity map. The informants were combined into six intermediate sensitivity maps: (1 biodiversity planning [CBA maps, plants species of conservation concern and expert mapped areas], 2 protected area expansion plans, 3 birds, 4 bats, 5 animals, and 6 aquatic ecosystems. Based on a maximum of the inputs at least 70% of the region is medium to very high sensitivity. This is expected as the region is a global biodiversity hotspot and this implies that there are high biodiversity sensitives in one form or another across almost the entire landscape.



Biodiversity sensitivities in the SEA regional landscape. Six intermediated sensitivity map are combined using a maximum of inputs (top map) and cumulation of inputs (bottom)

The cumulation of inputs indicates that only 11.5% of the region is very high sensitivity for 3 or more inputs. This indicates that there is some, but not a high degree of spatial correlation between the sensitivity inputs. In other words, areas important for plants are not necessarily also important for bats or birds. From the development perspective, this map illustrates where there might be more flexibility in the sensitivity map for development. For example, areas that are very high sensitivity for only one input implies that significant impacts may be lower and the required mitigation less than in an area that is very high for two or three inputs.

Three development scenarios are assessed (Baseline, Small GH2, Big GH2) each associated with increasing biodiversity loss. Impacts are grouped into two high-level groups: biodiversity pattern impacts (direct habitat/species loss), and ecological process impacts (disruption of processes, fragmentation). Mitigation emphasizes avoidance of sensitive areas, use of biodiversity offsets, and site-specific measures in relation to specific receptors. The consequence and likelihood of impacts with and without mitigation are considered similar, however, the risk assessment differs based on the contribution of sensitivity categories to achieving our conservation goals.

Strategic Management Actions include:

- Invest in the biodiversity knowledge base particularly data derived from RE operational monitoring, place this in the public domain and use this data to inform management aimed at avoiding, reducing and mitigating biodiversity impacts.

- Invest in refining spatial biodiversity planning with which to improve biodiversity informants for developing planning. A key immediate activity is the development of the regional biodiversity spatial framework to provide the spatial blueprint for protected area expansion, biodiversity offset implementation, developing the biodiversity economy and informing the spatial alignment of GH2 economy with the biodiversity economy.

- Plan for the biodiversity economy by aligning GH2 development with that of the biodiversity economy.

- Consider visual impacts of GH2 and explicitly plan for protecting the “wilderness” sense of place that the region’s most important tourism resource.

- Implement proactive mitigation and biodiversity offsets strategies to spatially and financially optimise the mitigation and offset requirements for the entire GH2 development, and to ensure alignment of offset objectives across all RE projects with the national biodiversity conservation goals and objectives.

- Invest in building a community of practice around RE in the region or South Africa generally to support growing human capital and support the adaptative management process by creating a forum for sharing of data and ideas between scientists, managers and regulators.

The Namakwa Region’s status as a global biodiversity hotspot requires careful and informed spatial planning to balance development (especially GH2 and renewables) with conservation. The sensitivity analysis demonstrates that while there is room for development, this must be strategically located to avoid undermining biodiversity conservation goals and the region’s economic potential founded on this biodiversity.

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CHAPTER 2. ECOLOGY, BIODIVERSITY AND CONSERVATION PLANNING

2.1 INTRODUCTION

As part of Work Package 2 for the Boegoebaai Strategic Environmental Assessment (SEA), this report presents a region assessment of biodiversity sensitives and risks in relation to three development scenarios (Table 2-1). The analysis integrates available biodiversity-related spatial planning informants, including those from WP1, to provide a regional perspective on the spatial distribution of biodiversity sensitivities across the Namakwa Region. This can be used at the desktop level to assess the impacts of future development and help development planning avoid high biodiversity sensitive areas at the planning stage.

Table 2-1: The spatial extent of the three development scenarios considered in the regional analysis.

Scenario	Assumed extent of biodiversity loss
Baseline	background biodiversity loss, <100 ha per year
Small GH2	21 082 ha
Big GH2	142 240 ha

In terms of report structure, the first section provides an overview of biodiversity patterns in the region. Only through better understating the spatial components of patterns of diversity and ecological processes in the landscape will we better able to consider or integrate biodiversity into land use planning.

The second section of the report provides a summary of the most significant current threats to biodiversity and is followed by an in-depth perspective on real-time climate change impacts observed in vegetation productivity trends.

The final part of the report integrates the available spatial biodiversity planning informants and taxon-specific assessments developed as part of this project into a single biodiversity sensitivity map for the WP2 region. Inputs to the biodiversity sensitivity analysis include:

1. Focus areas for protected area development combining protected area planning and development products from the implementing agencies and NGO partners in the region.

2. Plant-focused biodiversity sensitivity based on combining the available maps of critical biodiversity areas (Namakwa District 2009 and Northern Cape 2025) and other plant distribution information.

3. Bird biodiversity sensitivity prepared by Kellerman *et al.* (2026).

4. Bat biodiversity sensitivity prepared by Marais and Welch (2026).

5. Fauna biodiversity sensitivity prepared by Niemandt (2026).

6. Aquatic ecosystems sensitivity prepared by Day (2026).

The results of the sensitivity assessment are interpreted with regards to the spatial opportunities and constraints for regional development, and particularly a spatial perspective of where likely biodiversity offset receiving areas will be located. Whilst we cannot predict the future of development in the region, good spatial planning now can help the region prepare for and mitigate the impacts of current and future development pressures.

2.2 STUDY AREA

The study area for the regional assessment is the "Namakwa Region" includes the entire northern parts of the Namakwa District Municipality comprising the Kamiesberg, Khâi-Ma, Nama Khoi and Richtersveld Local Municipalities, an area of approximately 5.75 million ha (Figure 2-1).

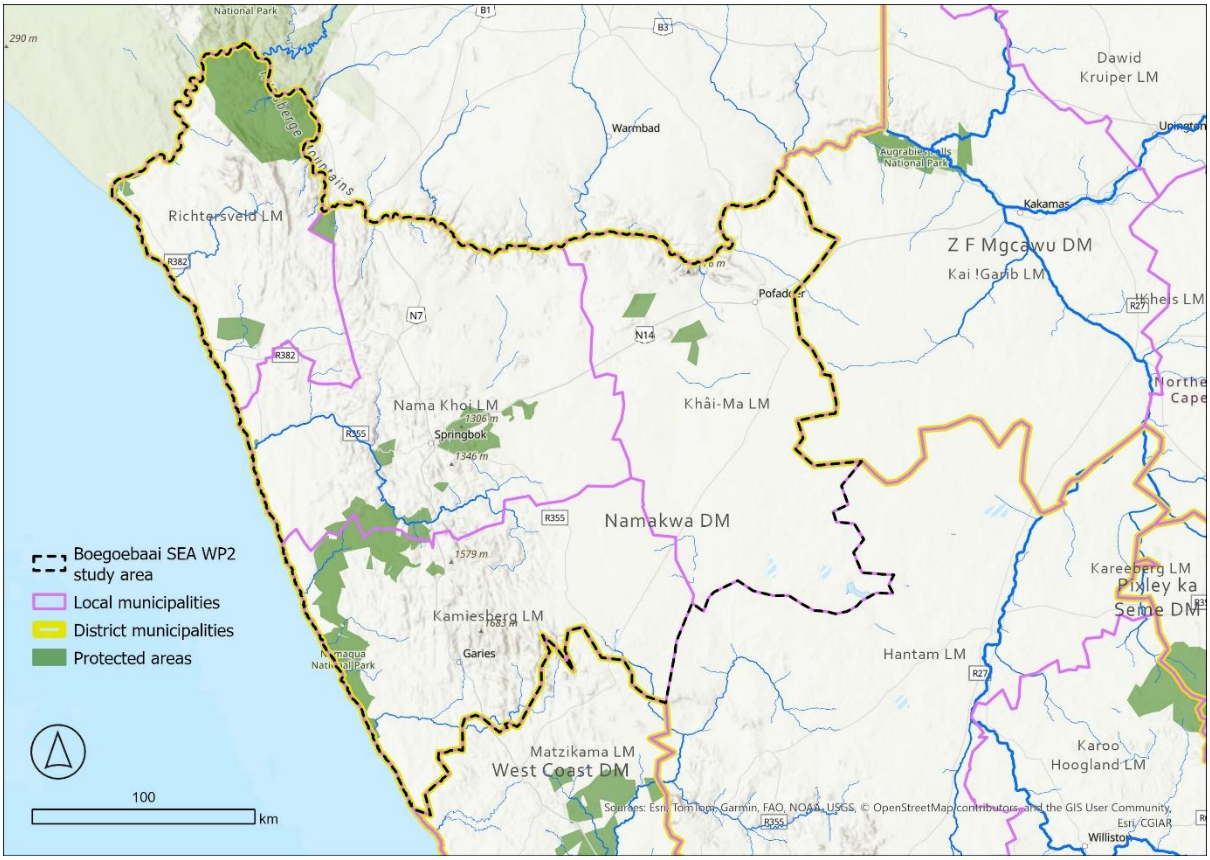


Figure 2-1: Location of the SEA study area in the north west of South Africa.

2.3 DESCRIPTION OF THE BASELINE RECEIVING ENVIRONMENT

2.3.1 *Patterns of Diversity*

The Namakwa Region lies in the north-west corner of South Africa. The region encompasses a wide coastal plain in the west adjoining the cold Atlantic Ocean; the north-south trending mountains of the African escarpment in the centre; wide-open sand-covered plains of the Bushmanland on the African plateau in the east; and the region is bounded in the north by the rugged Orange River valley.

This is a semi-arid to arid region (<250mm rain annually) that straddles a very important biogeographic boundary between the winter and summer rainfall zones of southern Africa. This boundary is orientated north to south in the east of the Namakwa Region running through the Bushmanland plains. Globally, the winter-summer rainfall divide is the most significant biogeographic boundary that there is in the world separating Mediterranean-type ecosystems (winter growing ecosystems) from all other ecosystems on earth (viz. summer-growing ecosystems). In southern Africa ecosystems of the winter-rainfall zone are grouped into the Greater Cape Floristic Region that includes the Fynbos and Succulent Karoo Biomes. The arid ecosystems in the summer rainfall zone are grouped into the Nama Karoo Biome.

The central and western parts of the Namakwa Region fall within the Namaqualand bioregion of the Succulent Karoo Biome. The Succulent Karoo is globally recognised as the most species diverse arid region in the world. On an area-equivalent basis the Succulent Karoo contains 2.65 times more species per unit area than the neighbouring Nama Karoo, and nearly 4 times more species than equivalent winter-rainfall deserts elsewhere in the world. The Namaqualand bioregion contains about 2800 species of plant in an area of about 100 000km^2 of which 27% are endemic to the bioregion (Snijman 2013). The exceptional biodiversity richness of the Succulent Karoo is the primary reasons why it is recognised as a global biodiversity hotspot and a priority focus area for biodiversity conservation.

The Namakwa Region is divided into nine distinct biophysical / biogeographic regions (bioregions) that reflect the impact that the underlying physical environment (primarily patterns of rainfall and substrates/geology) have on patterns of diversity across the region (Table 2-2) (Desmet 1997 and 2007; Snijman 2013, van Wyk and Smith 2001). Understanding these patterns of diversity in the region is the first step towards properly considering biodiversity in spatial planning and development decision making. Each bioregion is discussed in more detail in the sections that follow.

Table 2-2: A summary of the bioregion encountered in the Namakwa Region.

	Region	Bioregion	Biome
1	Coastal plain	Sandveld	Succulent Karoo
2		Hardeveld	Succulent Karoo
3	The Escarpment	Richtersveld Mountains	Succulent Karoo
4		Namaqualand Klipkoppe	Succulent Karoo
5		Kamiesberg Mountains	Fynbos
6	The Bushmanland	Bushmanland Sandy plains	Nama Karoo
7		Bushmanland Inselbergs	Succulent Karoo
8	Orange River Valley	Eastern Gariep	Desert
9		Western Gariep	Desert

2.3.1.1 <u>The Sandveld</u>

The great sand-covered coastal plain of Namaqualand is called the ***Sandveld***. Millenia of sand deposition by the sea and constant re-working by the wind have created a vast, mostly continuous sea-of-sand with a flora and fauna distinctly different to the rest of the region. As a general ecological rule, after rainfall seasonality and amount, sandy substrates vs other soil types (rocky colluvium or loam/clay) are next most important discriminator of ecosystems in the Succulent Karoo. The Sandveld is characterised by vast serene “wilderness” landscapes of strandveld vegetation. Pockets of plant diversity occur where inland habitats co-inside with the strandveld, such as along river valleys (e.g., Buffels River at Kleinzee) or rocky promontories along the coast (e.g., Boegoeberg). Whilst plant diversity in the strandveld is generally low by regional standards there are none-the-less a suite of species, notably fauna, that are endemic to the peculiarities of living in sand. For example, three species of fossorial mammals are endemic to the Sandveld: De Winton's golden mole (*Cryptochloris wintoni*) that is only know from the dunes around Port Nolloth; Van Zyl’s golden mole (*C. zyli*); and the rodent Namaqua dune molerat (*Bathyergus janetta*). Within the Sandveld in pockets of acid sandy soils, and especially in precipitation traps (i.e., fog traps in depressions) one encounters sandplain fynbos vegetation. This is a relic ecosystem that is more closely related to the fynbos on the high peaks of the Kamiesberg than to the vegetation communities in the surrounding Sandveld. The Sandveld sea-of-sand is kept in place by the veneer of strandveld that blanket the surface. Where this blanket is removed immediately causes sand mobilisation by the wind smothering vegetation in its path. This movement snowballs eventually creating plumes of actively moving sand marching northwards towards the Orange River. Nowhere is this more apparent than along the coast where a century of un-mitigated diamond mining activities has caused virtually the entire coastal landscape to begin moving.

2.3.1.2 The Hardeveld

On the coastal plain between the Sandveld and the base of the escarpment lies the ***Hardeveld*** with its characteristic "heuweltjies" or fossilised termitaria that create the distinctive pockmarking in the landscape. The soils are shallow over calcrete, loamy and base rich. The vegetation is dominated by short leaf-succulent vygies. Within the Hardeveld and usually associated with drainage lines are quartz gravel patches. Geologically these are a type of erosion gravel pavement, but only in the Succulent Karoo is there a unique biodiversity specifically adapted to this habitat type. Quartz patches (and other gravel patch types in the Succulent Karoo) with their associated biodiversity are a globally unique biodiversity phenomenon found now where else outside of the Succulent Karoo! From a spatial planning perspective gravel patches are a very high sensitivity habitat type and a key focus for conservation efforts.

2.3.1.3 Namaqualand Klipkoppe

The bulk of the African escarpment in Namaqualand is comprised the Namaqualand **Klipkoppe** bioregion. This is an extensive region of gneiss koppies and hills stretching from the break with the coastal plain (Hardeveld, ca. 300m) through to where the mountains of the escarpment merge with the sandy plains of the interior plateau (Bushmanland, ca. 800m). This region is synonymous with the spectacular spring flower displays that the region is famous for. Despite having a rich flora this region has comparatively few endemic species. This is perhaps because none of the habitat features generally associated with local centres of diversity are present in this bioregion (see Section 2.3.1.10). An interesting aspect of the regional vegetation, and which is encountered generally on mountains throughout the region, is the floristic affinities of vegetation on north vs south slopes. North-facing slopes are hot and generally support vegetation with summer-rainfall affinities especially the tree flora what are all palaeotropical affinities. South-facing slopes are cool and support winter growing vegetation with Succulent Karoo and other Cape Flora affinities.

2.3.1.4 The Kamiesberg

Located in the centre of the Namaqualand Klipkoppe bioregion is the granite massif of the **Kamiesberg**. Rooiberg (1700m) is the highest peak in the Namakwa Region and all the high peaks above 1200m support fynbos vegetation with renosterveld occupying upland valleys and plateaus between 900-1200m. These are fire-driven ecosystems typical of the Core Cape Flora that share few floristic affinities with the surrounding Succulent Karoo vegetation types. The Kamiesberg is a significant centre of endemism with at least 114 endemic or near-endemic species.

2.3.1.5 The Bushmanland Plains

East of the escarpment mountains, the entire eastern portion of the Namakwa Region is covered by the **Bushmanland** Plains bioregion. These expansive, gently undulating plains occupy the interior continental plateau at between 800-1100m. They are for the most part entirely covered with a thin veneer of red sand overlying a thick calcrete hardpan layer. The vegetation here is Bushmanland arid grassland, a species poor Nama Karoo Biome vegetation type but none-the-less highly productive and resilient vegetation type that is critical habitat for arid zone birds. To the south-east of the region, the sand sheet and desert grassland gives way to the barren rocky plains of the Bushmanland vloere, an even more species poor and depressing place for botanists. In the centre of these plains, the Koa River Valley marks south-north paleo river channel the ancient proto-Orange River. This valley is marked by the presence of large sand dunes that are the core habitat of the endemic Red Lark. This valley is also large enough to produce valley fog in the winter months that is an important moisture source for the Succulent Karoo vegetation on the surrounding inselbergs (see Section 2.3.1.6). Whilst the species diversity of these grasslands bares no comparison neighbouring Succulent Karoo vegetation units, around the fringes of this unit occur gravel patches on exposed calcrete or paleo river terraces each with their own suite of endemic plan species.

2.3.1.6 The Bushmanland Inselberg Region

At the northern end of the Bushmanland plains is a region of scattered inselbergs known as the **Bushmanland Inselberg** Region. These inselbergs are distributed in an east-west swathe marking approximately the southern edge of the Orange River valley. A feature of all these inselbergs is their relatively flat, quartzite-capped plateaus and associated quartzite rock/boulder covered scree-slopes and aprons, the presence of several types of gravel patches (quartzite, calcrete, feldspar), as well as the region being located on the ecotone between summer and winter rainfall zones. Therefore, the vegetation of the plains and warmer north-facing aspects is characteristic of the Nama Karoo Biome whereas that of cooler higher-elevation plains and south-facing aspects is characteristic of the Succulent Karoo Biome. The overlap of two biomes is a unique feature of the regions flora and sets these inselbergs apart from other inselbergs elsewhere in the Nama Karoo. The overlap of biomes is observed in the species of conservation concern. Of the 44 species of conservation concern know from the region, 7 have Nama Karoo affinities whereas the remainder all have Succulent Karoo affinities.

There are two ecological features of the inselberg region that are reflective of ecological patterns through the broader Namakwa Region and Succulent Karoo. These insights provide important lessons for spatial planning.

Firstly, The Bushmanland inselbergs effectively comprise an archipelago of rocky “islands” within a “sea” of sand. These “islands” share common floristic affinities but show distinct east-west and north south gradients in species turnover and population-level variation. The surrounding sandy plains form a continuous vegetation fabric that is widespread beyond this region, however, the inselbergs have very few species in common with the vegetation on the surrounding sandy plains – chalk and cheese! This pattern of diversity is demonstrated in across all regions discussed here. Key habitats are distributed as islands across the landscape, and each habitat island shows different patterns of diversity depending in its size and proximity to other islands. The ecology of species living on islands provide key ecological process principles that need to be considered in spatial planning.

Secondly, where the Bushmanland plains rise to approximately 1000m, rocky plains and inselbergs intersect the zone of winter-rainfall influence and Succulent Karoo vegetation makes an appearance in the form of Aggeneys Gravel Vygieveld. This vegetation type occurs as far east as Pofadder, is a distinctly Succulent Karoo vegetation type that occurs deep within the summer rainfall zone because the elevation at which it occurs it receives winter precipitation from passing cold fronts and valley fog from the Kao River valley. Similarly, the south facing slopes of the larger inselbergs support outposts of Namaqualand Klipkoppe vegetation. This vegetation typically occurs on rocky hills around Springbok, 100km to the west of these inselbergs. These vegetation anomalies point to the importance of aspect and elevation on quartzite rock and local precipitation traps are critical ecological components of climate change refugia.

2.3.1.7 Eastern Gariep

The lower Orange River valley east of the Richtersveld and north of the Bushmanland Plains is considered South Africa’s only true desert. Hot and dry, the ***Eastern Gariep*** Centre of Endemism stretches inland from the Richtersveld as far as Onseepkans. There are many endemic plant species associated with this centre of endemism, but unlike in the valley to the west of the Richtersveld where the flora is derived from the Greater Cape Flora, here species have family affinities with Africa’s summer-rainfall or Afro-tropical deserts such as the Namib, Kaokoveld, Kalahari and even the Horn of Africa. However, as with the adjacent Bushmanland Inselberg Region to the south, the high mountains peaks above 1100m intersect the winter rainfall zone and contain outposts of the Succulent Karoo vegetation. This Eastern and Western Gariep (see Section 2.3.1.9) bioregions are classified as Desert Biome in South Africa and not Succulent Karoo.

2.3.1.8 The Richtersveld

The Richtersveld mountains terminate the northern end of the African escarpment in South Africa. At first glance, the Richtersveld is part of an entirely different geological suite to Namaqualand, giving rise to rugged landscapes with steeply trending mountains of metamorphic rocks with high peaks and sheltered valleys. The central mountain ranges of the ***Richtersveld*** are possibly the most species diverse centre of endemism within the Succulent Karoo biome. More than 2000 plants species have been recorded from the Richtersveld with at least 305 considered endemic plants (P. van Wyk pers. Comm.). This topographic and geologically diversity area is home to a wide diversity of life. North-facing slopes tend to harbour elements with summer rainfall affinities, whereas south-facing slopes are home to the winter-rainfall elements associated with the Greater Cape Flora. The highest peaks are wet enough to still have remnants of Renosterveld and Fynbos vegetation types (Fynbos Biome). South slopes and high elevation areas are important climate change adaptation habitats for species – these are locally mesic (wetter, cooler) habitats that provide species with refuge when climates become more arid or hotter. Consequently, there are many "paleo-relic" species associated with these habitats. These are species characteristic of the Core Cape Flora far to the south with outlying occurrences in the Richtersveld.

A key trend in the patterns of diversity in the Richtersveld, as with all bioregions in the Succulent Karoo, is that this diversity is not distributed evenly throughout the landscape. Concentrations of species of conservation concern occur in distinct local nodes of diversity Each area represents a local hotspot that hosts components of the endemic flora of the Richtersveld. These areas are mostly topographic features such as mountains that provide unique and often isolated evolutionary niches for species. Mountainous areas provide more habitats for biodiversity due to greater diversity of geology (rock chemistry); geomorphology (physical properties); aspect (exposure to the sun); elevation (cooling and increased moisture); refuge from disturbance (grazing); and, in many cases increase moisture availability (e.g., fog traps). Some plains areas are also noted as being centres of diversity and all are associated with the occurrence of gravel plains of various types: the lower Orange River valley around Alexander Bay; Sun Valley; and the quartz gravel patches southeast of Eksteenfontein, the Holgat River and, Lekkersing.

These local areas of endemism are highly sensitive from a development perspective. Throughout the Namakwa Region all such areas mapped by biodiversity experts are a key informant of high sensitivity zones for development.

2.3.1.9 Western Gariep

In the Orange River valley west of the Richtersveld from Sendelingsdrift to Alexander Bay is the ***Western Gariep*** Centre of Endemism. This is the southern boundary of the ***Namib Desert.*** Just south of Alexander Bay, the Boegoeberg inselbergs mark the boundary on the coast between Namaqualand and the Namib Desert. This winter-rainfall section of the Namib Desert is the most northern extent of the Succulent Karoo biome, and stretches northwards to Lüderitz in Namibia, and inland as far as the western mountains of the escarpment. This arid area is still well within the winter-rainfall zone, and frequent fog from the Atlantic Ocean is the primary source of moisture in this landscape. Many plant species are endemic specifically to this small geographic area. At its western extremity, the area from Brandkaros to Alexander Bay and Oranjemund has possibly the most endemic rich vegetation in South Africa, a testament to the highly unique environment found here.

Included in this area is South Africa's largest ***lichen field*** just outside the town of Alexander Bay. This is the world's most species-rich lichen field, and whilst there are extensive lichen fields in the central Namib these bare no comparison in terms of species diversity or biomass to this lichen field at Alexander Bay. It is truly a global wonder!

2.3.1.10 Key biodiversity patterns informing spatial planning.

From our understanding of the local and regional patterns in the occurrence and distribution of biodiversity in the Namakwa Region it is possible to summarise important spatial aspects of these patterns of diversity that are important to consider in spatial planning and decision making:

1. Exceptionally high levels of plant species diversity and endemism. The likelihood of any development impacting species of conservation concern is generally high throughout the region. This likelihood is very high in the many local centres of diversity recognised throughout the region.

2. Plant species diversity is not evenly distributed through-out the landscape. Distinct local geographic areas with concentrations of species of conservation concern are recognised that from a plant conservation perspective are the most important areas for species conservation in the region. For the most part these are generally well mapped in the region.

3. The reasons for the occurrence of these centres of diversity are varied. Several habitats are well known to be associated with higher species diversity or concentrations of endemic species. These include:

    a. Gravel patches (quartz, calcrete, feldspar, paleo-river terraces)
    b. Quartzite mountain systems
    c. Climate refugia habitats (south-facing slopes, high mountains and plateaus, precipitation traps, dune systems, kloofs)
    d. Relic ecosystems specifically fynbos (depressions in the Sandveld) and renosterveld (escarpment edge) ecosystems.

4. Close observation of patterns of diversity highlights elements of local ecosystems that provide climate change refugia for species. The ecological attributes of habitats that support extra-limital populations of species provide useful insights into to what ecological factors to include in spatial planning for climate change resilience. Factors such as aspect and elevation are easy to map or model from a digital elevation model. Other factors are more nuanced such as moisture traps. This can only reliably be mapped through experts identifying these areas based on field experience.

2.3.2 Biodiversity Status and Trends

Biodiversity and ecosystems in the Namakwa Region face a multitude of pressures that are or can lead to the outright loss or degradation of the natural environment thereby undermining societies' ability to achieve sustainable development goals. When assessing the impact of any development it is important to understand the current status of biodiversity and the anthropogenic pressures driving trends in natural systems, and how the development will interact with these threats.

Significant threats currently facing biodiversity in the region are summarised in Table 2-3. There are many other threats facing biodiversity in the region that are not discussed here. That is because they are either not considered a significant driver of biodiversity loss within the regional context (e.g., alien invasive species), or the threats have a local impact that is not considered significant (e.g., off road driving, hunting, urban development). Threats that lead to permanent loss of natural habitat, especially over large areas, and loss or decline in populations of species of conservation concern are consider highly significant threats. Ecosystem degradation threats such as livestock grazing, whilst impacting large areas, are potentially reversible therefore are considered significant.

It is very important to have some perspective on novel or developing economic activities, and where and how they may impact the biodiversity. These can present potentially significant threat to biodiversity. This perspective can help prioritise where conservation action should focus to minimise the impact of new threats. Good spatial planning will be critical for ensuring that novel land uses develop in an appropriate and environmentally sustainable manner.

Largescale developments that are on the horizon for the Namakwa Region include:

- The hydrogen economy, the motivation behind this study, and the expansion of renewable energy to meet the energy demand for this industry is highly likely. This industry has the potential to impact very large areas and will possibly be the largest driver of habitat loss in the short term.

- There are still extensive reserves of mineral sands throughout the Sandveld, and it is only a matter of time until these resources are exploited. The open-cast moving-pit mining model used by current mineral sand operations along the coast target whole landscapes or ecosystems and have the potential to destroy significantly more habitat than what the diamond miners have achieved. For example, the current mineral sand mine at Namakwa Sands stretches the entire width of the Sandveld and the pit area is currently 20 000 ha in extent and growing. The sheer spatial scale of this type of operation dwarfs that of the diamond mines.

- It is also likely that with the advent of cheap or surplus electricity in the region, the cost of desalinating sea water will become cost effective for the developing tunnel agriculture. It is not unreasonable to envision large swaths of the Sand being covered in poly-tunnels.

The impact of climate change is discussed separately in the following section.

Table 2-3: A summary of the major threats currently facing biodiversity in the Namakwa Region.

Activity	Description of Impact	Biodiversity Impact	Potential area of impact	Notes
Livestock grazing	Livestock eating natural vegetation	Loss of ecosystem function (reduction in plant cover and species diversity, increased soil erosion and runoff)	Widespread impacting the whole region	Livestock grazing is the most widespread land use activity in the region. The impact is strongly dependent on land tenure, i.e., impact varies across properties. Within the context of climate change and promoting ecosystem resilience managing livestock grazing is the single most important threat to manage given the wide spatial extent.
Current mining	Construction and operation of mine	Outright loss of habitat at mine site. Degradation of ecosystems in neighbourhood (dust and runoff)	Restricted to mine site and local neighbourhood	Underground pit mining activities tend to be focussed on specific sites. These can have significant species or habitat-level impacts especially where they coincide with biodiversity features of conservation concern. These impacts need to be managed on a case-by-case basis. Future open-cast mining for mineral sands in the Sandveld is an emerging threat that will impact very large areas (>100 000ha)
Historic mining at Alexander Bay	Legacy mining impacts continuing to self-propagate and expand area of impact.	Loss of habitat as a direct result of wind erosion and sand deposition	Neighbourhood to region	Along the Port Nolloth to Alexander Bay coast the historic impacts of legacy mining operation are continuing to self-propagate. This is currently South Africa's largest mining-related environmental disaster. This impact will continue to grow without significant intervention.
Renewable energy - solar	Construction of solar farms	Loss of habitat due to site clearing	Widespread	The construction of solar farms will be the largest driver of habitat loss in this region in the short term. This magnitude of this loss will be directly related to the development of green hydrogen activities South Africa.
Renewable energy - wind	Operation of wind farms	Reduction in bird and bat populations due to turbine strikes	Widespread	Reduction in the size of wild populations increases the risk of species extinction as smaller, more fragmented populations are less resilient to stochastic events. It is highly likely that we will see the extinction of certain bird or bat species in the region if wind energy facilities are scaled to support the hydrogen economy. As bats are apex predators controlling insect populations, the loss of bats form ecosystems can have catastrophic cascading ecosystem-level
Aerial Linear infrastructure	Operation of transmission lines	Reduction in bird populations due to collisions and electrocutions	Widespread	As previous point.
Poaching of biodiversity	Illegal collecting of plant and animal species from wild populations	Reduction in population sizes doe to collecting	Widespread impacting all areas	Possibly the most important threat is currently facing biodiversity in the region as we are seeing extinction of species in real time. Reduction in the size of wild populations increases the risk of species extinction as smaller, more fragmented populations are less resilient to stochastic events.

2.3.2.1 Climate Change and Ecosystem Degradation

Climate change is the most important short-, medium- and long-term threat to biodiversity and society in the region. The most recent climate change Succulent Karoo biome response analysis (Guo et al. 2017) indicates, as in previous assessments, that the Desert biome is expected to increase in extent in Namaqualand by 2070 (Figure 2-2) implying significantly hotter and drier conditions becoming the norm within the next 50 years.

This prediction appears to be confirmed by looking at actual vegetation productivity trend data for the region.

A vegetation productivity trend analysis was conducted using Landsat derived enhanced vegetation index (EVI) comparing two 34-year time series Figure 2-3). Time series one, 1984 to 2018, coincides with the end of a large drought event in the region. Time series two, 1990 to 2024, coincides with a period of recovery following the drought. For each time series a linear regression is fitted to annual EVI data (Venter et al. 2020) and the trend result is expressed here as a % change (slope) in EVI relative to the baseline (intercept) EVI value.

Comparing the two trend maps in Figure 2-3 one can see considerable recovery in vegetation post the drought that ended in 2018 whilst in other areas the browning (degrading) trend observed in the first time series continues post drought.

The two time series outputs were combined and re-classified into different vegetation trend categories to reflect degrading, static or greening of vegetation.

1984-2018 Trend	1990-2024 Trend	Combined Trend Category
Negative	Negative	Degraded
Greening	Negative	Degrading
No change	Negative	Degrading
Negative	Greening	Recovering
Negative	No change	Recovering
No change	No change	Static
Greening	No change	Static
No change	Greening	Greening
Greening	Greening	Greening

At the regional level it is clearly apparent the arid zone of South Africa is experiencing significant and widespread browning of vegetation Figure 2-4). This is interpreted here as being representative of degraded or degrading ecosystems (i.e., reduction in long term vegetation productivity). Within the region, the most sever degrading trends are concentrated in the northwest of the region in the Richtersveld bioregionFigure 2-5). The largescale degradation of ecosystems observed in this analysis is confirmed by on the ground observation (Jürgens et al. 2025). The trends differ across vegetation types (ecosystems) suggesting that the underlying ecological characteristics of vegetation types also play a role in how vegetation is responding to climate change (Figure 2-6 and Table 2-4).

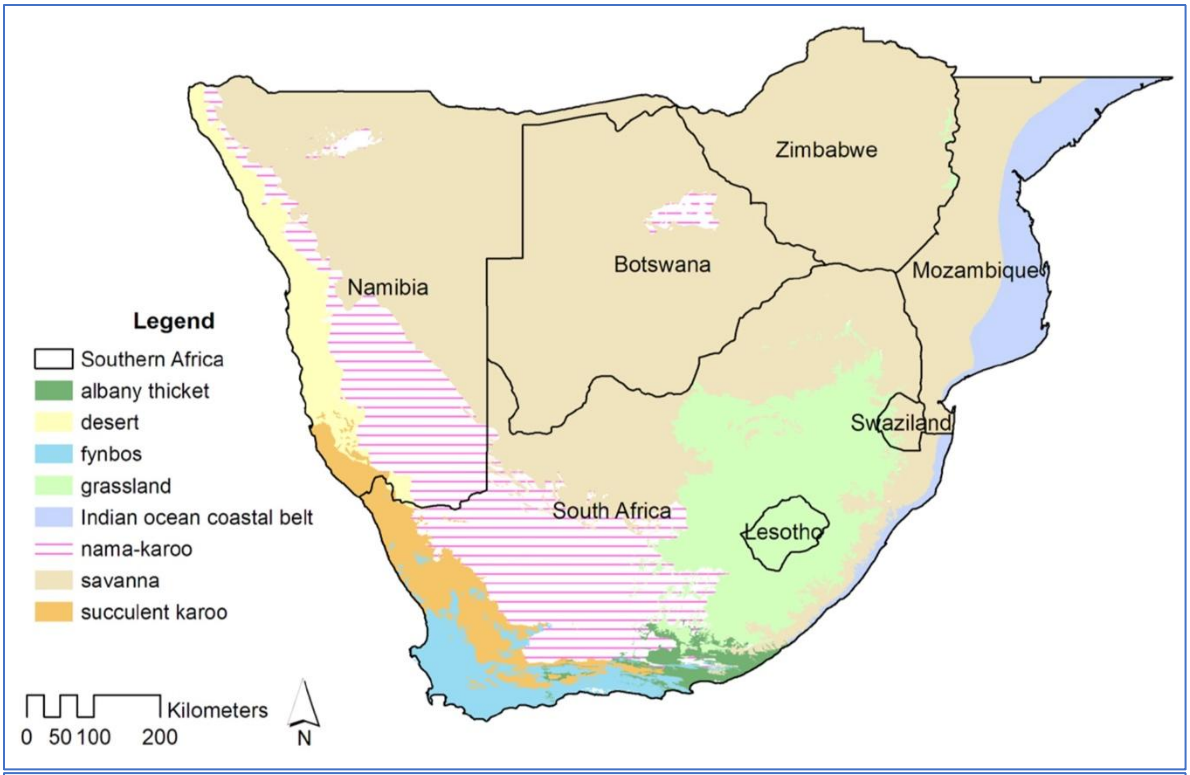
Land use, specifically livestock grazing, does impact the trend in vegetation productivity. Whilst the EVI trend dataset has not been analysed to specifically differentiate the climate change vs land use impact, there are some inferences we can make from the current analysis. Vegetation productivity trends are compared between a long term protected area with low stock rates (Namaqua National Park) and the surrounding areas. Very clear fence-line contrasts can be observed between the park and surrounding areas (Figure 2-7). A pairwise comparison between vegetation types shared between the park and neighbouring areas show on average 50% less (22% of vegetation type extent inside versus 42% outside) degraded area compared to outside the park (Table 2-5). The Namaqua National Park is the only large area in northern Namaqualand showing a net neutral EVI trend. This suggests that livestock grazing is a very important factor mediating the impact of climate change.

Some important observation from the vegetation trend analysis include:

- Climate change is a reality for Namaqualand. Most vegetation types show negative productivity trends with the most extreme values observed in the northwest of the region.

- Trends differ between vegetation types. Whilst climate change and land use are probably the two most important factors determining trend, underlying ecological characteristics of each ecosystem (vegetation type) are also an important variable. For example, Bushmanland arid grasslands on sand appear to be much more resilient than neighbouring Bushmanland vloere shrubland on rocky substrates.

- Land use specifically livestock grazing appears to be a very important mediator of climate change impact on vegetation productivity trend. Possibly the most important climate change adaptation intervention that can be made in this region is to manage livestock impacts. This observation also highlights the role that well managed protected areas can play in mitigating climate change impacts. Significantly more protected areas are required in the region if this mitigation impacts are to be scaled to deliver benefits the whole ecosystem.



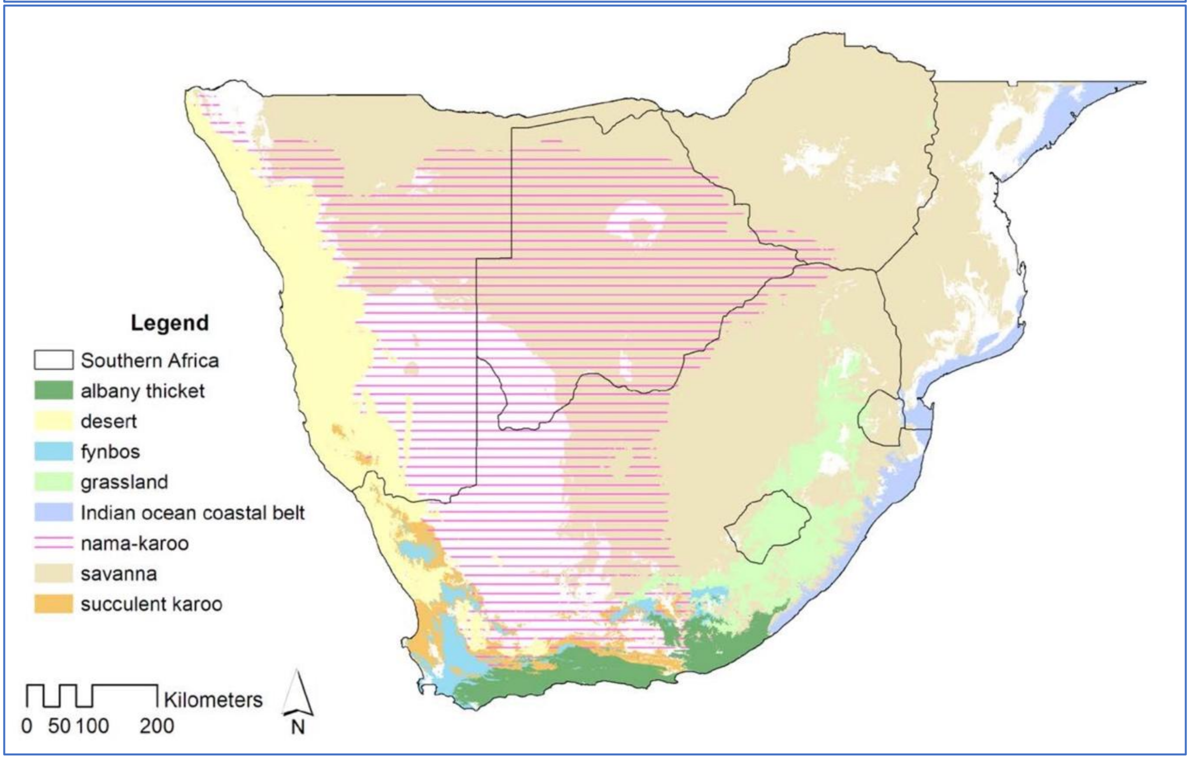


Figure 2-2: Extent of southern African biomes under current (top) and future (2070, bottom) climate scenarios (from Guo et al. 2017).

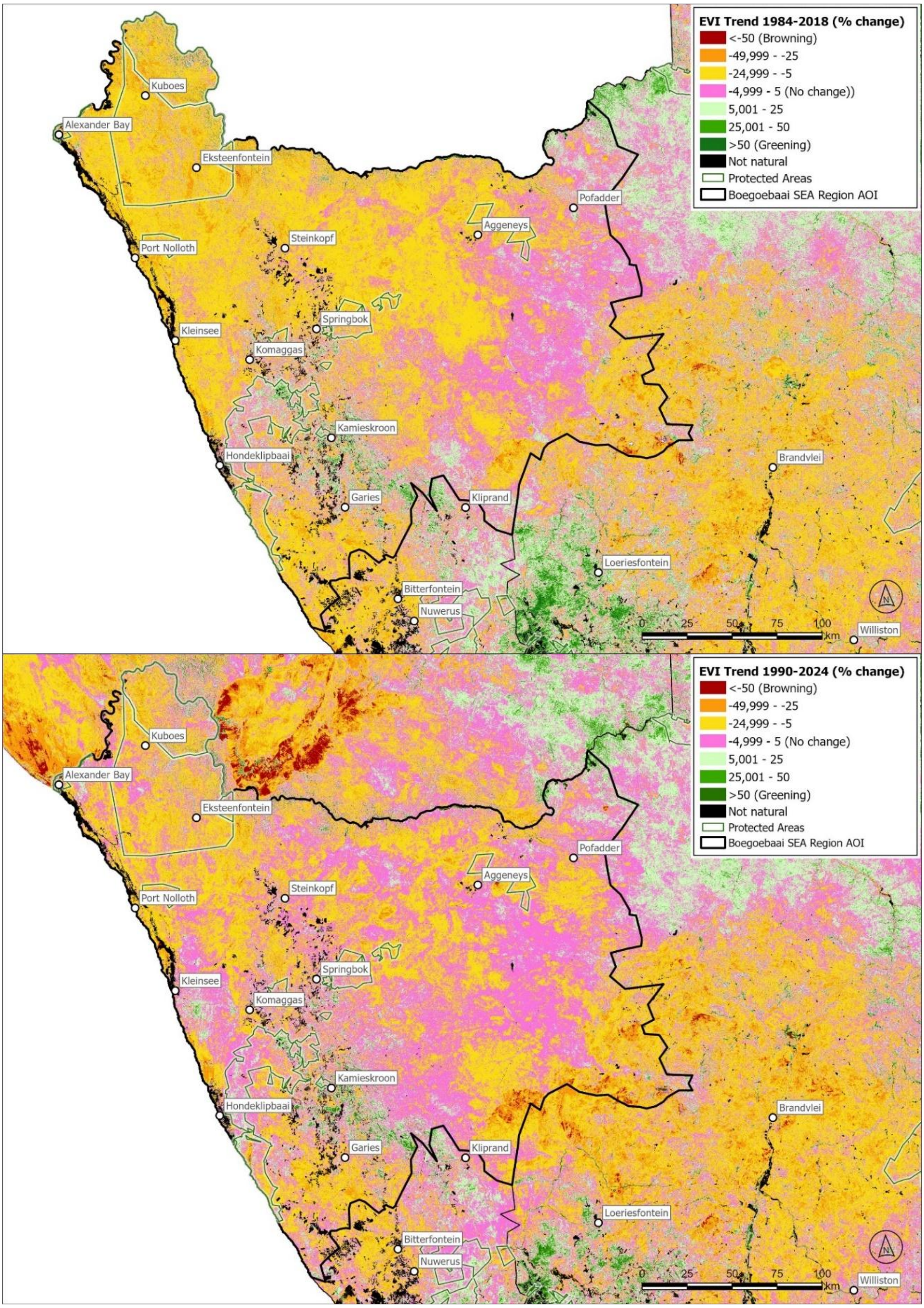


Figure 2-3: Trend in vegetation productivity in the Namakwa Region for two 34-year trend periods.

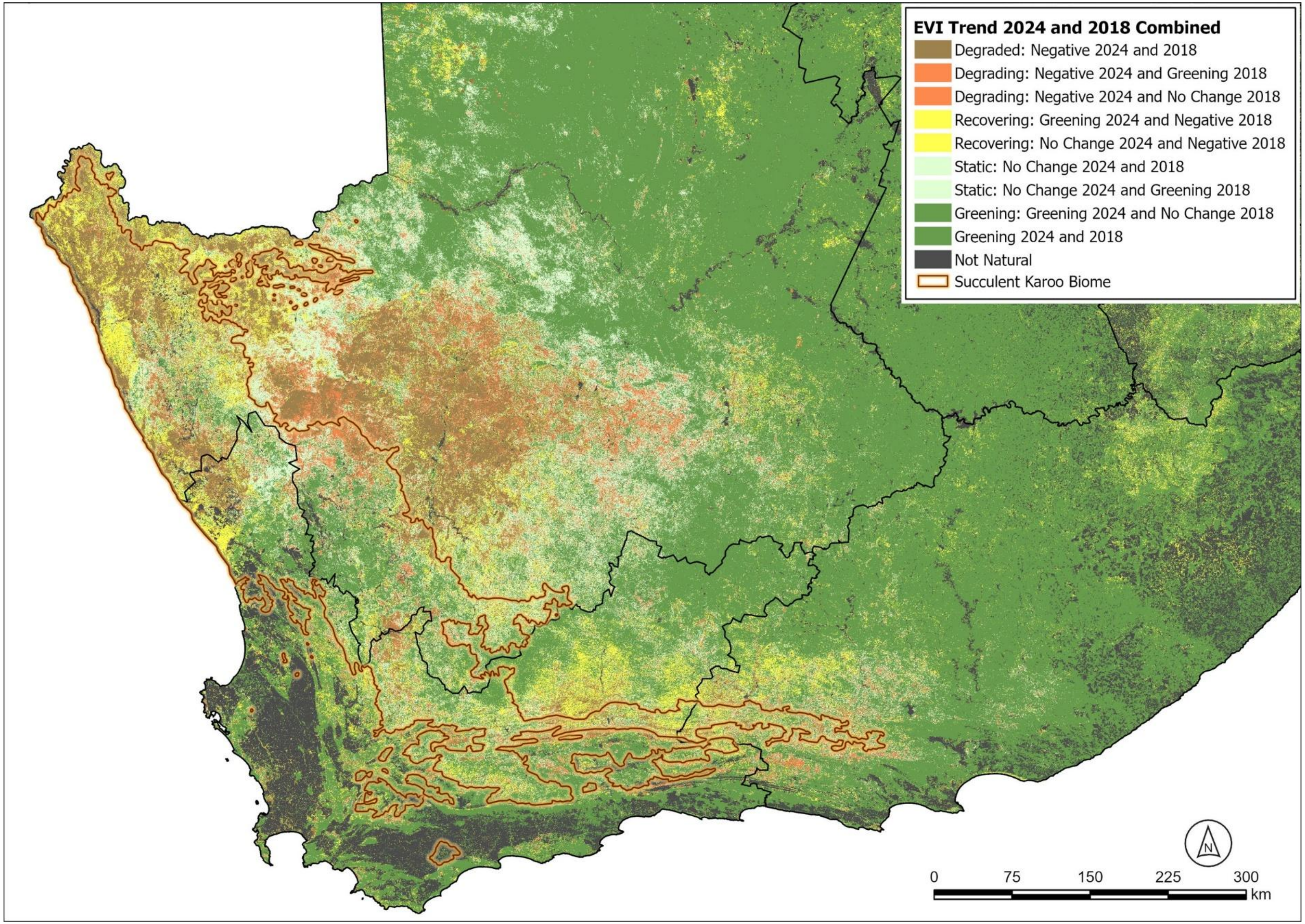


Figure 2-4: The vegetation productivity trend for the arid zone of South Africa based on a combination of the trend analysis for two 34-year time series (1984-2018 and 1990-2024).

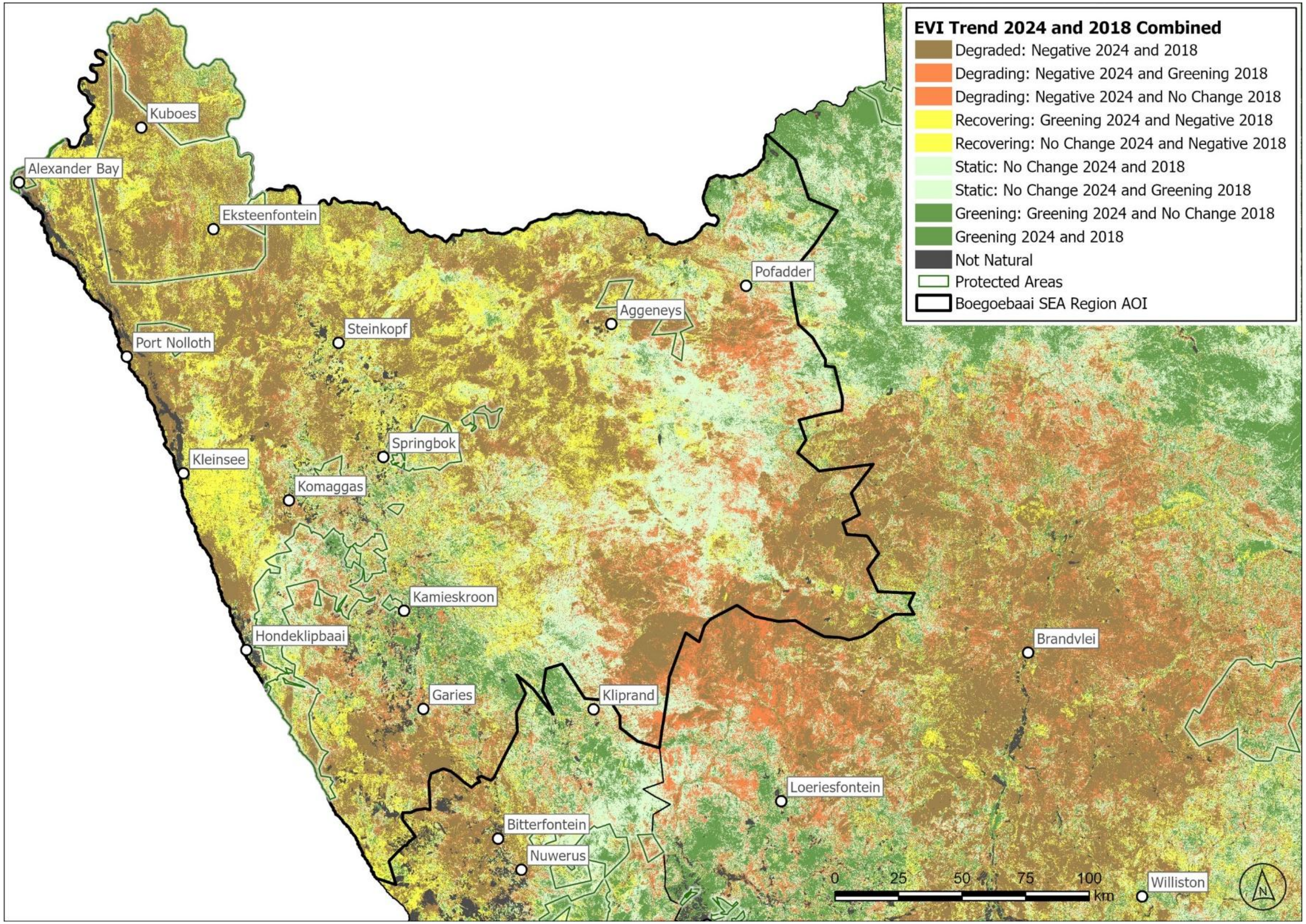


Figure 2-5: The vegetation productivity trend for the Namakwa Region based on a combination of the trend analysis for two 34-year time series (1984-2018 and 1990-2024).

Table 2-4: A summary of vegetation productivity trends within vegetation types. Table is sorted from most degraded to least degraded.

VEGETATION TYPE	EVI Trend 1990 to 2024								EVI Trend 1984 to 2018								Combined EVI Trend 2024 vs 2018									
	< -50 Strong Browning	-50 - -25 Browning	-25 - -5 Some Browning	-5 - 5 No Change	5 - 25 Some Greening	25 - 50 Greening	>50 Strong greening	2024 Sum of Browning	< -50 Strong Browning	-50 - -25 Browning	-25 - -5 Some Browning	-5 - 5 No Change	5 - 25 Some Greening	25 - 50 Greening	>50 Strong greening	2018 Sum of Browning	Degraded: Negative 2024 & 2018	Degrading: Negative 2024 & Greening 2018	Degrading: Negative 2024 & No Change 2018	Recovering: Greening 2024 & Negative 2018	Recovering: No Change 2024 & Negative 2018	Static: No Change 2024 & 2018	Static: No Change 2024 & Greening 2018	Greening: Greening 2024 & No Change 2018	Greening 2024 & 2018	Sum of Degrading
Vyftienmyl se Berge Succulent Shrubland	-	17	79	4	-	-	-	96	-	11	78	8	3	-	-	88	86	7	3	2	1	1	-	-	-	96
Bushmanland Inselberg Shrubland	-	18	63	18	-	-	-	81	-	13	69	14	3	-	-	82	82	10	2	1	1	2	1	1	1	94
Alexander Bay Coastal Duneveld	9	31	49	8	3	-	-	89	12	68	16	2	2	-	-	95	87	1	-	6	-	1	2	-	1	89
Lekkersing Succulent Shrubland	-	7	91	-	2	-	-	98	-	13	74	11	2	-	-	87	80	7	1	3	6	1	1	1	-	88
Richtersveld Sandy Coastal Scorpionstailveld	-	7	76	17	-	-	-	83	-	15	79	5	-	-	-	94	82	3	-	14	-	-	-	-	-	85
Richtersveld Coastal Duneveld	1	19	61	17	3	-	-	80	-	28	65	5	2	-	-	93	77	2	1	14	2	1	2	1	1	80
Namib Seashore Vegetation	-	32	48	18	-	2	-	80	-	42	46	2	2	6	2	88	78	2	-	13	-	4	-	-	2	80
Kosiesberg Succulent Shrubland	-	11	17	64	7	1	-	28	-	-	76	19	5	1	-	76	65	11	-	18	1	2	1	1	1	76
Aggeneys Gravel Vygieveld	-	1	73	25	1	-	-	74	-	3	65	27	5	-	-	68	55	18	2	13	9	2	-	1	-	75
Rooiberg Quartz Vygieveld	-	2	73	24	1	-	-	75	-	17	78	4	-	-	-	95	73	2	-	22	2	-	-	-	-	75
Western Gariep Hills Desert	1	9	60	27	3	-	-	70	1	30	59	6	2	1	1	90	67	3	1	23	-	1	2	1	1	71
Southern Richtersveld Yellow Duneveld	-	6	91	-	2	-	-	97	-	17	78	5	-	-	-	95	68	2	-	26	3	-	1	-	-	70
Southern Richtersveld Inselberg Shrubland	-	5	64	30	1	-	-	69	-	4	74	19	3	-	-	78	58	9	2	19	9	2	-	1	-	69
Western Bushmanland Klipveld	-	5	63	30	1	-	-	68	-	-	24	47	28	1	-	25	23	33	12	2	13	15	-	-	1	68
Namaqualand Shale Shrubland	-	10	60	24	5	1	-	70	-	19	64	15	1	1	-	83	66	1	2	16	6	3	2	2	2	68
Namaqualand Seashore Vegetation	5	29	35	18	6	3	4	69	1	24	47	10	8	4	6	72	57	6	4	12	3	4	2	2	10	67
Noms Mountain Desert	-	9	58	25	6	1	1	67	-	10	64	18	1	3	3	75	52	9	5	14	6	5	3	2	4	67
Bushmanland Vloere	1	1	39	36	15	4	4	41	1	18	11	6	43	12	8	31	50	12	5	2	17	-	5	7	2	67
Bushmanland Basin Shrubland	1	14	49	24	10	2	1	63	-	9	55	3	25	6	1	65	45	15	6	1	9	10	1	2	10	67
Southern Richtersveld Scorpionstailveld	-	5	61	33	1	-	-	66	-	13	78	8	1	-	-	92	62	3	-	28	5	-	1	-	-	66
Rosyntjieberg Succulent Shrubland	-	7	58	20	7	4	3	65	-	26	55	7	6	3	4	81	59	3	3	16	2	2	6	2	7	65
Central Richtersveld Mountain Shrubland	-	9	55	26	7	2	1	64	-	20	64	14	1	1	1	84	56	6	2	19	5	2	4	3	2	64

VEGETATION TYPE	EVI Trend 1990 to 2024								EVI Trend 1984 to 2018								Combined EVI Trend 2024 vs 2018									
Southern Nababiepsberge Mountain Desert	-	13	50	25	9	1	1	63	1	25	58	10	4	1	1	84	60	3	1	19	4	1	5	3	3	63
Northern Richtersveld Scorpionstailveld	-	1	62	34	3	-	-	63	-	14	75	10	1	-	-	89	59	4	-	28	5	1	2	-	-	63
Platbakkies Succulent Shrubland	-	1	8	89	3	-	-	9	-	1	91	4	4	-	-	92	52	10	-	4	29	3	1	1	1	62
Stinkfonteinberge Eastern Apron Shrubland	-	4	58	36	2	-	-	62	-	35	62	2	-	-	-	97	61	1	-	35	1	-	1	-	-	62
Stinkfonteinberge Quartzite Fynbos	-	12	23	11	41	11	2	35	-	15	65	14	5	1	-	80	54	4	1	21	5	2	6	4	3	60
Namaqualand Heuweltjieveld	-	6	55	37	1	1	-	61	-	1	11	58	30	-	-	12	43	10	2	13	13	7	2	3	5	56
Northern Richtersveld Yellow Duneveld	-	2	53	40	4	-	-	55	-	9	83	7	1	-	-	92	53	2	-	36	4	-	3	1	-	55
Eastern Gariep Plains Desert	-	1	39	49	10	1	-	40	-	1	63	28	7	-	-	64	44	9	1	4	24	4	4	5	5	55
Oograbies Plains Sandy Grassland	-	1	51	47	1	-	-	52	-	5	89	5	-	-	-	95	51	1	-	43	4	-	-	-	-	52
Richtersveld Red Duneveld	-	1	48	49	2	-	-	48	-	5	86	9	-	-	-	91	50	2	-	45	1	-	1	1	-	51
Kwaggarug Mountain Desert	-	5	46	34	12	1	1	51	-	2	67	18	8	2	3	69	46	3	2	23	8	4	5	5	5	51
Kahams Mountain Desert	-	4	72	1	16	4	3	76	-	11	64	15	8	3	-	75	43	4	2	25	7	4	5	3	7	49
Southern Namaqualand Quartzite Klipkoppe Shrubland	-	4	45	33	15	3	-	49	-	6	44	28	19	3	-	50	35	11	4	12	12	9	3	5	9	49
Eenriet Plains Succulent Shrubland	-	-	49	48	3	-	-	49	-	2	97	1	-	-	-	99	47	2	-	40	7	-	2	1	-	49
Eastern Gariep Rocky Desert	-	3	48	44	1	2	2	52	-	6	54	25	12	2	1	59	37	7	2	19	14	6	3	4	7	46
Umdaus Mountains Succulent Shrubland	-	1	45	50	3	-	-	46	-	3	80	14	2	-	-	83	42	3	-	40	10	1	2	1	1	46
Goariep Mountain Succulent Shrubland	-	2	50	44	1	2	-	52	-	16	75	2	6	1	-	91	41	4	1	30	7	2	8	4	3	46
Northern Nababiepsberge Mountain Desert	-	3	42	40	10	2	2	46	1	24	61	9	3	1	2	85	43	2	1	35	4	2	7	3	4	46
Anenous Plateau Shrubland	-	1	40	47	11	1	-	41	-	4	60	27	8	1	-	64	32	8	1	28	15	4	4	5	3	41
Richtersveld Sheet Wash Desert	-	1	39	49	9	1	-	41	-	12	83	1	3	-	-	95	39	2	-	43	6	1	4	4	2	41
Richtersberg Mountain Desert	-	2	34	40	18	4	2	36	-	6	51	21	13	5	4	57	30	5	3	24	11	7	5	1	14	38
Namaqualand Riviere	1	5	31	33	18	6	6	37	-	4	32	3	37	14	10	36	18	9	10	8	10	16	2	5	23	37
Tatasberg Mountain Succulent Shrubland	-	-	35	45	14	3	2	36	-	1	37	26	19	10	7	37	20	9	7	15	13	17	2	4	13	36
Western Gariep Lowland Desert	-	1	34	56	8	-	-	35	1	58	36	3	2	-	-	94	35	1	-	52	4	-	6	2	-	35
Namaqualand Klipkoppe Shrubland	-	-	32	44	19	4	1	32	-	4	8	69	5	11	2	12	22	9	3	16	18	12	3	1	16	35
Hantam Karoo	-	6	25	29	27	11	3	31	-	2	2	27	44	20	5	4	15	9	8	5	9	16	1	-	35	33
Namaqualand Strandveld	-	1	22	48	23	5	1	22	-	-	64	25	9	1	-	65	31	-	-	5	18	-	18	15	11	32
Namaqualand Granite Renosterveld	-	2	28	35	27	7	2	29	-	2	29	29	32	7	1	31	18	7	4	10	14	11	3	8	25	29
Riethuis-Wallekraal Quartz Vygieveld	-	-	28	66	6	-	-	28	-	-	22	52	25	1	-	23	11	14	3	11	36	19	-	2	3	28
Namaqualand Blomveld	-	1	26	58	14	1	-	27	-	-	60	38	2	1	-	60	22	5	1	29	22	7	3	6	7	27
Namaqualand Sand Fynbos	-	1	23	47	25	3	1	24	-	4	52	29	14	1	-	56	21	4	1	28	16	6	12	10	1	26
Namaqualand Heuweltjie Strandveld	-	1	23	45	26	5	1	24	-	9	68	18	5	-	-	77	24	2	-	38	-	2	22	8	3	26
Helskloof Canyon Desert	-	1	24	55	19	-	-	25	-	22	68	8	1	-	-	91	25	-	-	51	4	-	15	4	1	25
Namaqualand Inland Duneveld	-	1	24	52	21	2	-	25	-	7	65	22	6	-	-	71	22	2	-	36	13	3	13	7	4	25
Bushmanland Arid Grassland West	-	1	42	53	4	-	-	43	-	-	48	43	8	-	-	49	4	17	2	26	37	8	1	3	2	23
Upper Annisvlakte Succulent Shrubland	-	-	47	51	2	-	-	47	-	6	89	5	-	-	-	95	7	14	1	7	47	1	20	3	1	21
Die Plate Succulent Shrubland	-	2	61	35	1	-	-	64	-	29	63	8	1	-	-	92	13	6	1	66	10	1	2	1	-	20
Namaqualand Coastal Duneveld	1	14	43	28	13	1	1	57	1	38	16	32	10	2	2	54	10	8	2	39	10	3	15	7	6	20
Non-terrestrial (estuarine habitat)	8	4	9	18	18	17	27	20	9	8	13	26	21	2	23	29	8	3	6	5	-	10	6	9	52	18

VEGETATION TYPE	EVI Trend 1990 to 2024								EVI Trend 1984 to 2018								Combined EVI Trend 2024 vs 2018									
Lower Gariep Alluvial Vegetation	5	4	9	18	16	16	32	18	2	6	12	9	17	17	37	19	10	2	5	5	3	9	5	5	56	17
Namib Lichen Fields	-	1	16	36	40	7	-	17	-	2	25	39	35	-	-	27	14	2	-	10	17	9	2	20	25	17
Kamiesberg Mountains Shrubland	-	1	12	27	34	17	8	14	-	1	16	23	38	16	6	17	8	4	3	1	10	11	4	10	49	15
Kamiesberg Granite Fynbos	-	1	15	45	5	22	11	16	-	-	13	25	40	15	5	14	5	4	2	6	12	13	3	10	45	11
Western Gariep Plains Desert	1	5	34	37	23	-	-	40	1	2	73	20	1	2	-	76	5	4	2	40	9	6	17	10	8	11
Lower Gariep Broken Veld	-	1	8	25	39	20	7	9	-	-	7	17	42	23	11	8	4	3	3	3	1	16	1	7	63	10
Bushmanland Sandy Grassland	-	-	17	81	2	1	-	17	-	-	27	52	18	1	2	27	1	6	2	19	45	16	1	-	10	8
Northern Knersvlakte Vygieveld	-	-	11	63	25	1	-	11	-	-	10	68	11	10	-	10	2	-	5	-	25	39	-	7	21	8
Namaqualand Arid Grassland	-	-	6	49	40	5	-	6	-	-	1	42	52	4	-	1	2	3	1	5	24	20	1	12	31	6
Bushmanland Arid Grassland East	-	-	3	31	50	14	2	4	-	-	3	22	54	18	3	3	1	2	1	1	11	18	1	9	56	3
Blouputs Karroid Thornveld	-	-	6	79	12	2	2	6	-	-	4	27	56	11	1	4	1	1	1	2	14	19	1	11	49	3

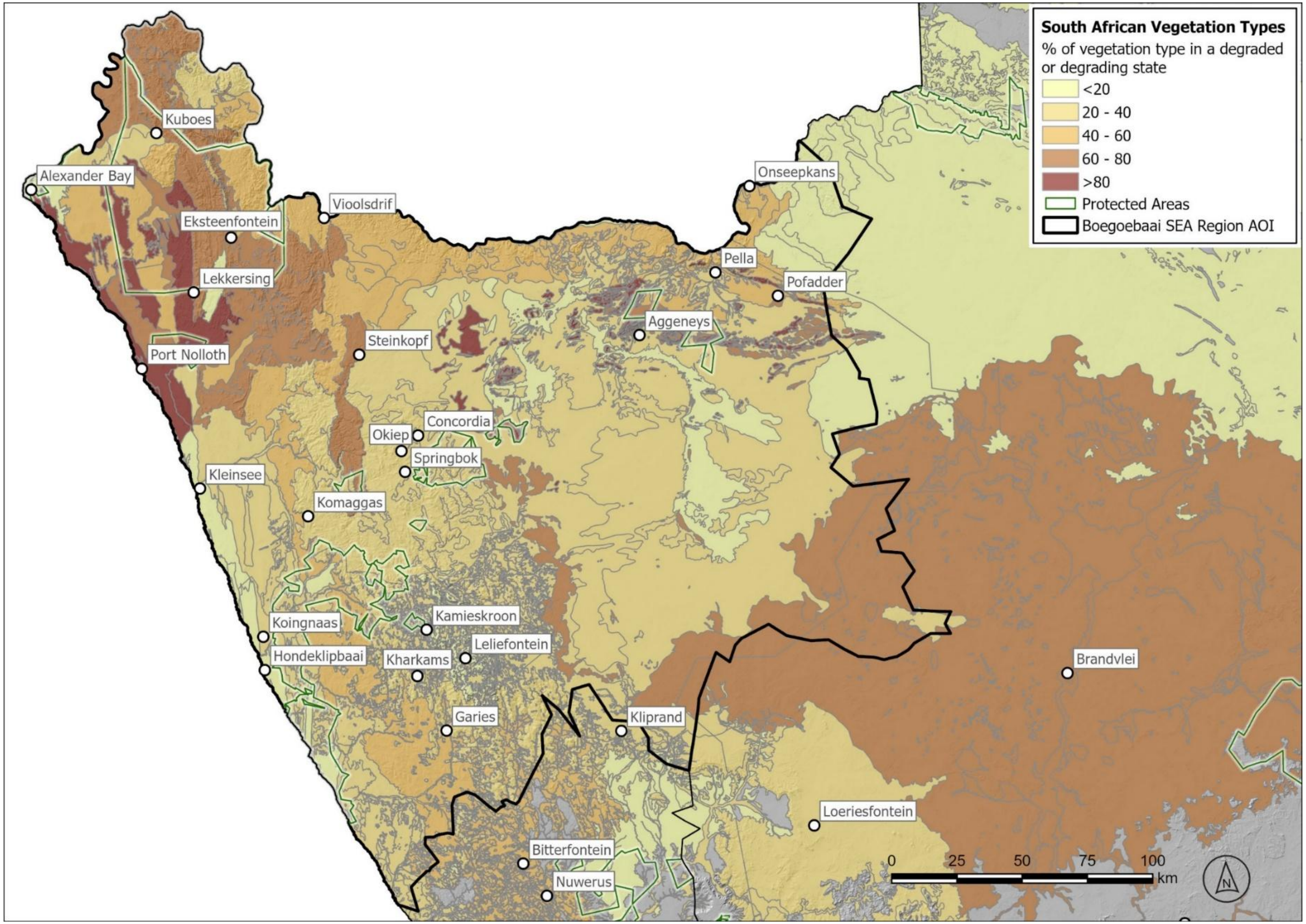


Figure 2-6: The extent of degradation across vegetation types in the Namakwa Region (The proportion of a vegetation considered to be degraded or in a degrading state).

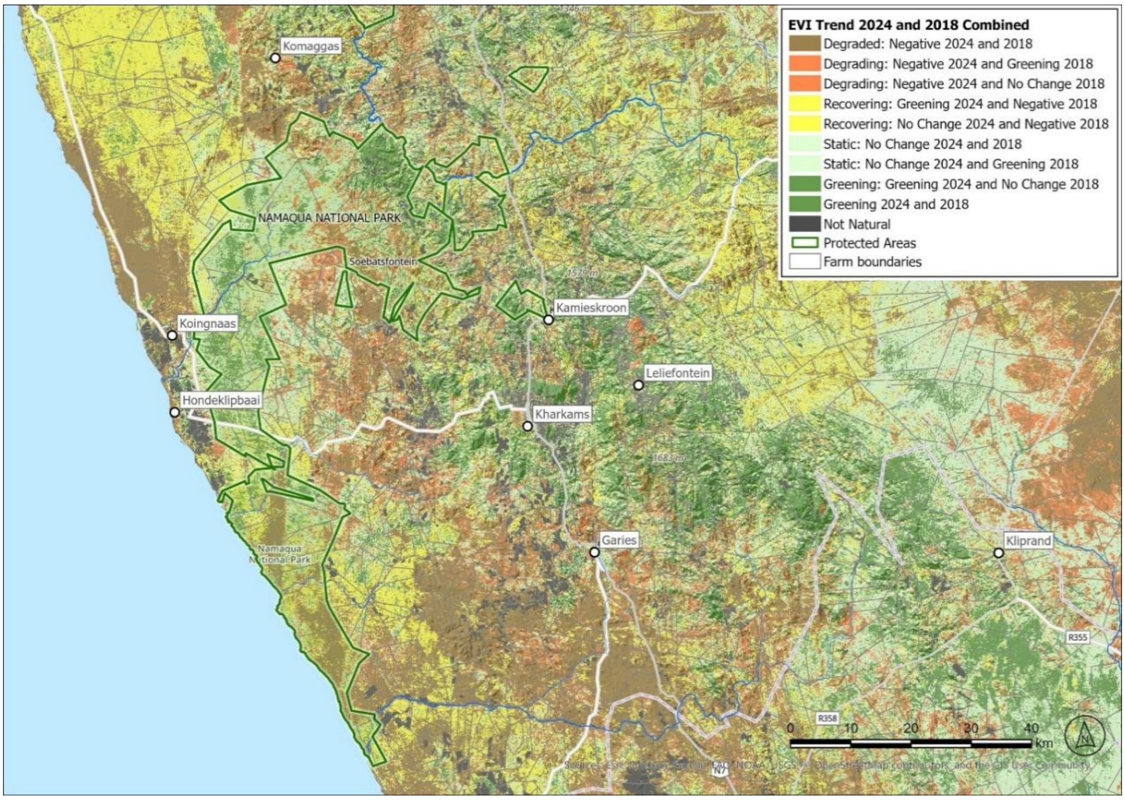


Figure 2-7: Trend in vegetation primary productivity (EVI) comparing the Namaqua National Park to surrounding areas (see Table 2-5 for an area summary of trends within vegetation types inside and outside the park).

Table 2-5: A comparison of vegetation productivity trends in vegetation types between the Namakwa National Park and surrounding areas.

Namakwa National Park:	Outside of park										Inside park										
Vegetation Type	Degraded: Negative 2024 and 2018	Degrading: Negative 2024 and No Change 2018	Degrading: Negative 2024 and Greening 2018	Recovering: No Change 2024 and Negative 2018	Recovering: Greening 2024 and Negative 2018	Static: No Change 2024 and 2018	Static: No Change 2024 and Greening 2018	Greening: Greening 2024 and No Change 2018	Greening 2024 and 2018	Sum of degraded classes	Degraded: Negative 2024 and 2018	Degrading: Negative 2024 and No Change 2018	Degrading: Negative 2024 and Greening 2018	Recovering: No Change 2024 and Negative 2018	Recovering: Greening 2024 and Negative 2018	Static: No Change 2024 and 2018	Static: No Change 2024 and Greening 2018	Greening: Greening 2024 and No Change 2018	Greening 2024 and 2018	Sum of degraded classes	% Difference in extent of degraded vegetation IN versus OUTSIDE the park
Kamiesberg Mountains Shrubland	5,4	3,6	2,9	5,1	3,5	9,2	11,6	9,4	49,2	11,9	0,3	1,7	1,2	0,9	1,5	7,6	10,5	12,2	64,2	3,2	73,1
Namaqualand Arid Grassland	0,0	0,0	0,1	5,7	1,0	24,0	14,6	26,6	28,1	0,1	1,8	5,6	1,7	5,2	0,3	33,7	26,8	6,0	18,9	9,1	
Namaqualand Blomveld	21,5	8,3	2,5	22,8	5,2	17,2	6,9	7,4	8,0	32,3	7,3	5,9	2,7	15,2	5,0	19,2	11,6	11,7	21,5	15,9	50,8
Namaqualand Coastal Duneveld	58,8	6,3	1,6	11,7	2,4	7,3	3,5	3,1	5,4	66,7	57,0	6,3	1,6	14,8	2,9	7,5	2,3	4,0	3,7	64,9	2,7
Namaqualand Granite Renosterveld	17,0	9,2	4,8	7,9	2,3	14,8	13,3	6,9	23,8	31,0	0,0	0,4	0,4	3,5	1,4	14,8	10,9	16,5	52,1	0,8	97,4
Namaqualand Heuweltjie Strandveld	39,5	3,2	0,2	39,5	4,9	8,2	1,1	2,6	0,9	42,9	20,0	5,9	1,2	27,0	6,8	20,6	7,8	7,3	3,5	27,1	36,8
Namaqualand Heuweltjieveld	38,6	14,7	3,7	11,4	1,3	16,3	8,4	2,3	3,3	57,0	15,2	12,9	5,7	7,3	0,6	22,8	25,0	2,5	8,0	33,8	40,7
Namaqualand Inland Duneveld	35,4	3,7	0,6	32,5	4,7	13,4	2,6	4,4	2,6	39,7	6,2	3,2	0,6	19,3	4,0	28,9	12,3	12,3	13,3	10,0	74,8
Namaqualand Klipkoppe Shrubland	19,0	9,9	3,5	14,1	3,0	18,5	11,4	6,8	13,8	32,4	12,6	9,3	4,5	9,9	2,0	16,0	15,1	6,2	24,4	26,4	18,5
Namaqualand Riviere	47,2	12,0	5,3	12,8	3,2	8,9	5,1	2,7	2,9	64,5	21,8	12,8	4,8	12,9	1,7	21,3	14,9	3,2	6,7	39,4	38,9
Namaqualand Sand Fynbos	27,1	6,7	1,9	24,7	3,1	18,6	7,4	5,3	5,1	35,7	2,7	1,5	0,7	13,1	2,3	30,5	16,5	14,0	18,7	4,9	86,3
Namaqualand Seashore Vegetation	66,3	8,1	5,8	4,7	1,2	3,5	4,7	0,0	5,8	80,2	42,0	4,2	4,2	10,9	0,8	1,7	2,5	3,4	30,3	50,4	37,2
Namaqualand Strandveld	31,0	3,9	0,4	35,2	4,9	15,1	2,7	4,2	2,5	35,3	5,4	2,9	0,9	14,3	7,3	25,2	10,7	17,7	15,6	9,2	73,9
Riethuis-Wallekraal Quartz Vygieveld	21,1	26,5	6,8	6,1	0,1	23,6	15,3	0,2	0,3	54,4	6,8	8,7	2,1	13,4	0,4	41,1	20,2	2,4	4,8	17,6	67,6
Average	30,6	8,3	2,9	16,7	2,9	14,2	7,8	5,9	10,8	41,7	14,2	5,8	2,3	12,0	2,6	20,8	13,4	8,5	20,4	22,3	53,8

2.3.2.2 Ecosystem Status

The International Union for Conservation of Nature (IUCN) Red List of Ecosystems (RLE) framework has been adopted and adapted by South African National Biodiversity Institute (SANBI), within the National Biodiversity Assessment (NBA) process, as the standards to assess the risk of collapse for its ecosystems. The SANBI uses the RLE framework as part of its periodic National Biodiversity Assessment (NBA), the country's primary tool for monitoring and reporting on the state of its biodiversity to inform national policy and conservation decisions. The NBA is a collaborative project that synthesizes scientific data on South Africa's biodiversity. The assessments, which have been conducted since 2004, cover all realms: terrestrial, freshwater, estuarine, and marine. The RLE framework is a critical component of the NBA, providing the scientific foundation for assessing the status of South Africa's ecosystems.

The RLE is a key informant of policy and decision-making across various sectors, such as water, agriculture, and mining. Within land use planning and decision making RLEs influence the nature and extent of acceptable land use activities and where and how biodiversity offsets should be applied.

The current 2025 RLE status of ecosystems indicates only a 9 (12%) out of 71 vegetation types are considered threatened ecosystems in the region (Figure 2-8

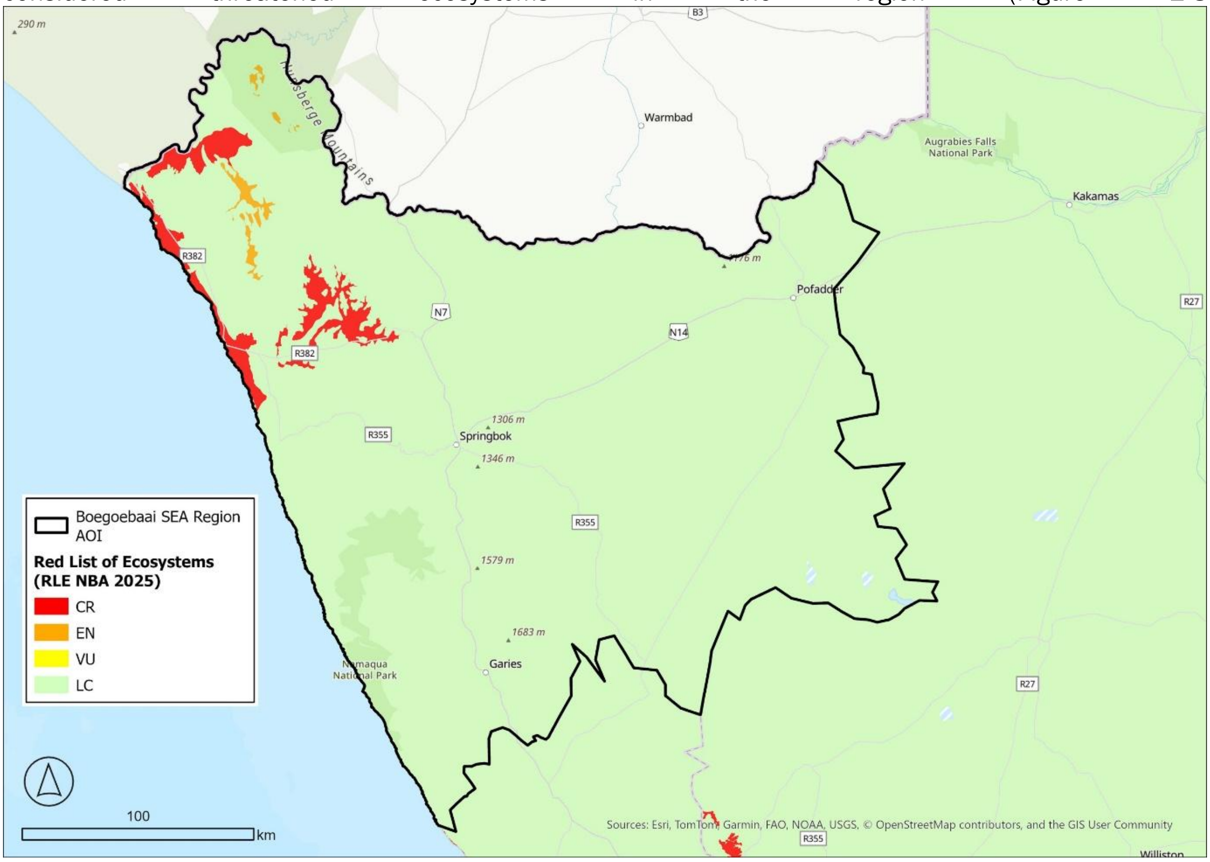


Table 2-6). This assessment, however, only considers degradation process (criterion D) for a few selected ecosystems in the Richtersveld and not widely across the region. So, whilst the NBA 2025 analysis reflects the best available published data sources in its assessment, it does not consider current trends in degradation across the region. In the light of the data presented in Section 2.3.2.1 this is perhaps not an accurate reflection of the actual status of ecosystems in the region.

RLE criterion D1 is applied here using the data in Table 2-4, specifically the combined 2024 and 2018 data and only the degraded class (negative trend in 2024 and 2018). Criterion D1 assesses the disruption of biotic processes or interactions that occurred over the past 50 years. It evaluates the change in a specific biotic variable across a fraction of the ecosystem's extent and with a relative severity, using quantitative thresholds to determine the risk category.

An ecosystem is listed in a threatened category under Criterion D1 if the combination of the extent of the ecosystem affected and the relative severity of the change in a key biotic variable meets or exceeds the thresholds of >80% = Critically Endangered (CR), 50-80% = Endangered (EN) and 30-50% = Vulnerable (VU). The variable used in this analysis is the extent of an ecosystem considered in a degraded state defined here as areas with a significantly negative trend (<-25%) in EVI in both 2018 and 2024 trend analysis. Both trend analyses are 34 years duration so partially overlapping. The period from 2018 to 2024 is a recovery periods after a major drought ending in 2018. Whilst many areas show significant recovery after this drought many areas also show continued negative EVI trends, and therefore the conclusion that these areas are degraded.

The RLE analysis including the D1 criterion indicates that 44 (62%) of the 71 vegetation types in the region are considered threatened (**Error! Reference source not found.**,Table 2-6). When combined with the NBA 2025 assessment, the total number of RLE increases to 46 (65%) of vegetation types considered threatened (Figure 2-10, Table 2-6).

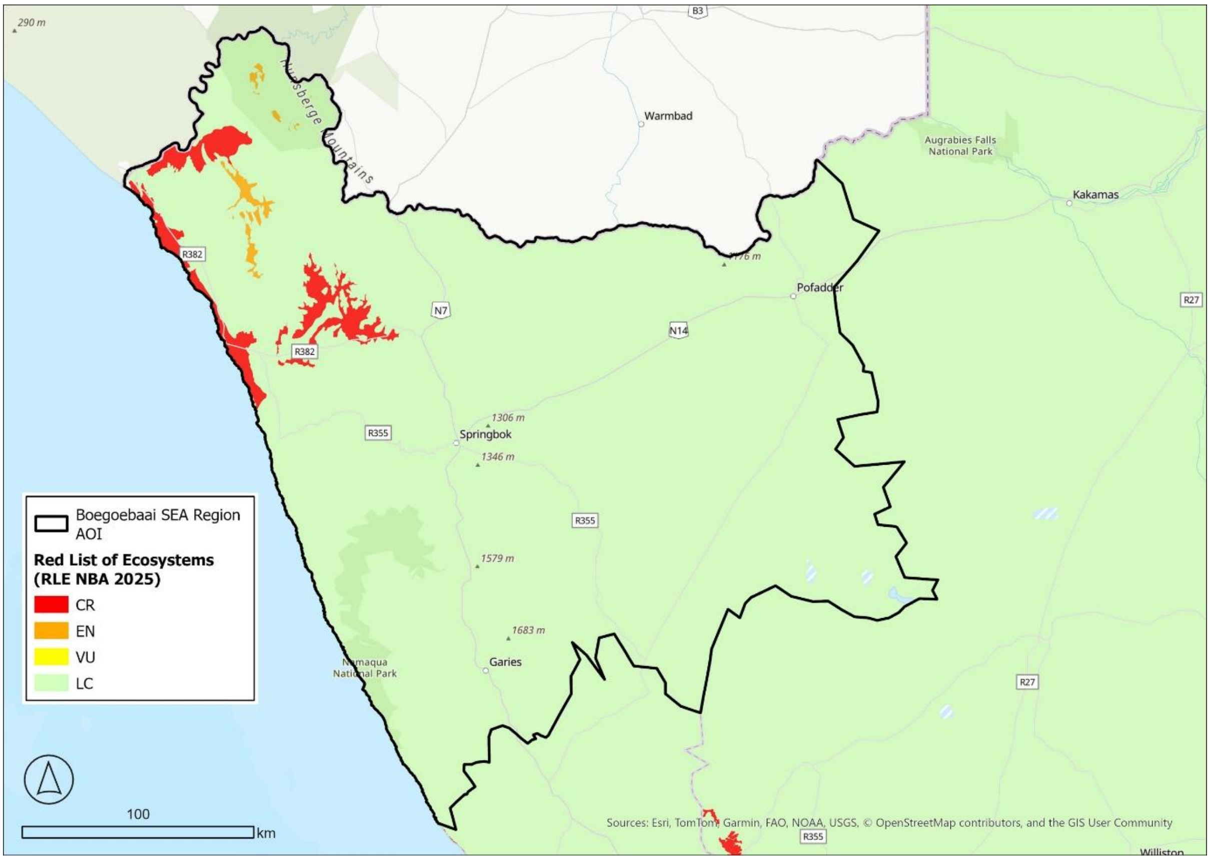


Figure 2-8: The Red List of Ecosystems (RLE) according to the NBA 2025.

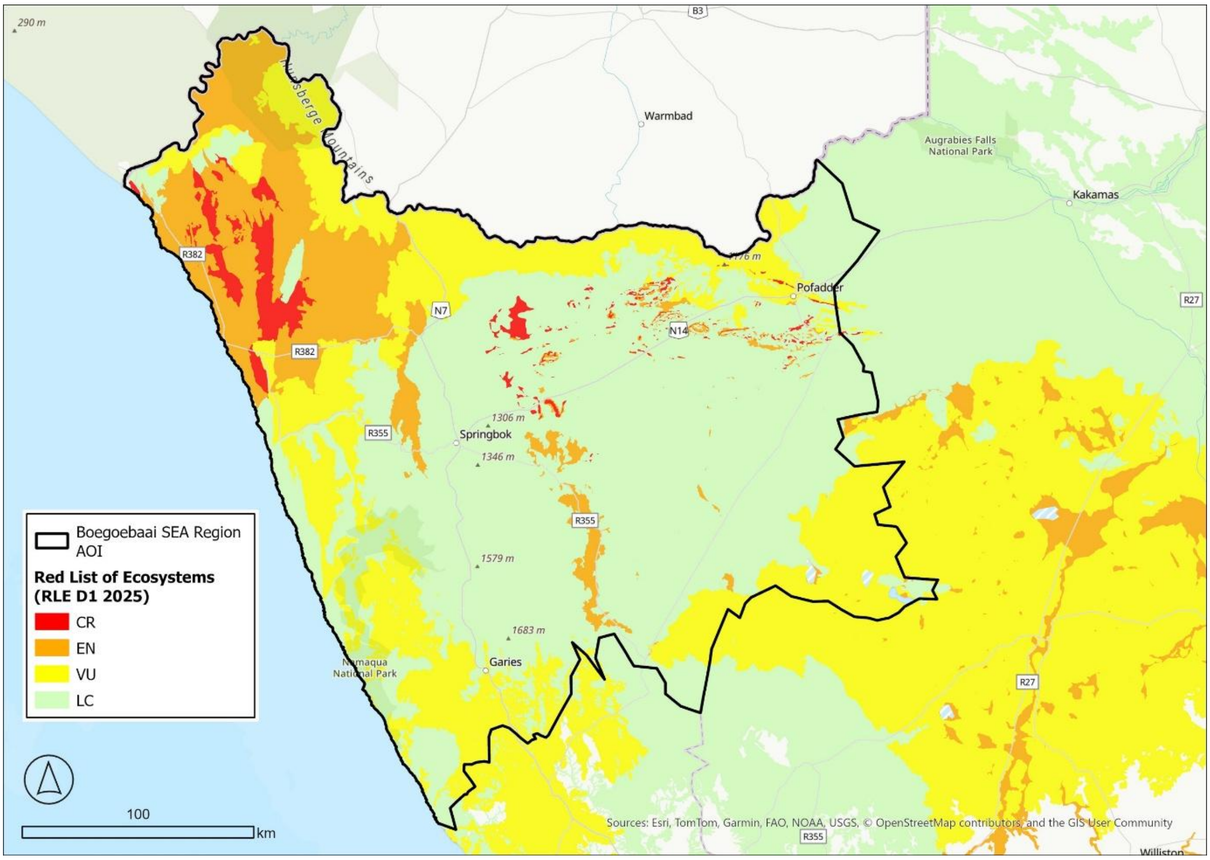


Figure 2-9: The combined NBA 2025 and D1 Red List of Ecosystems (RLE).

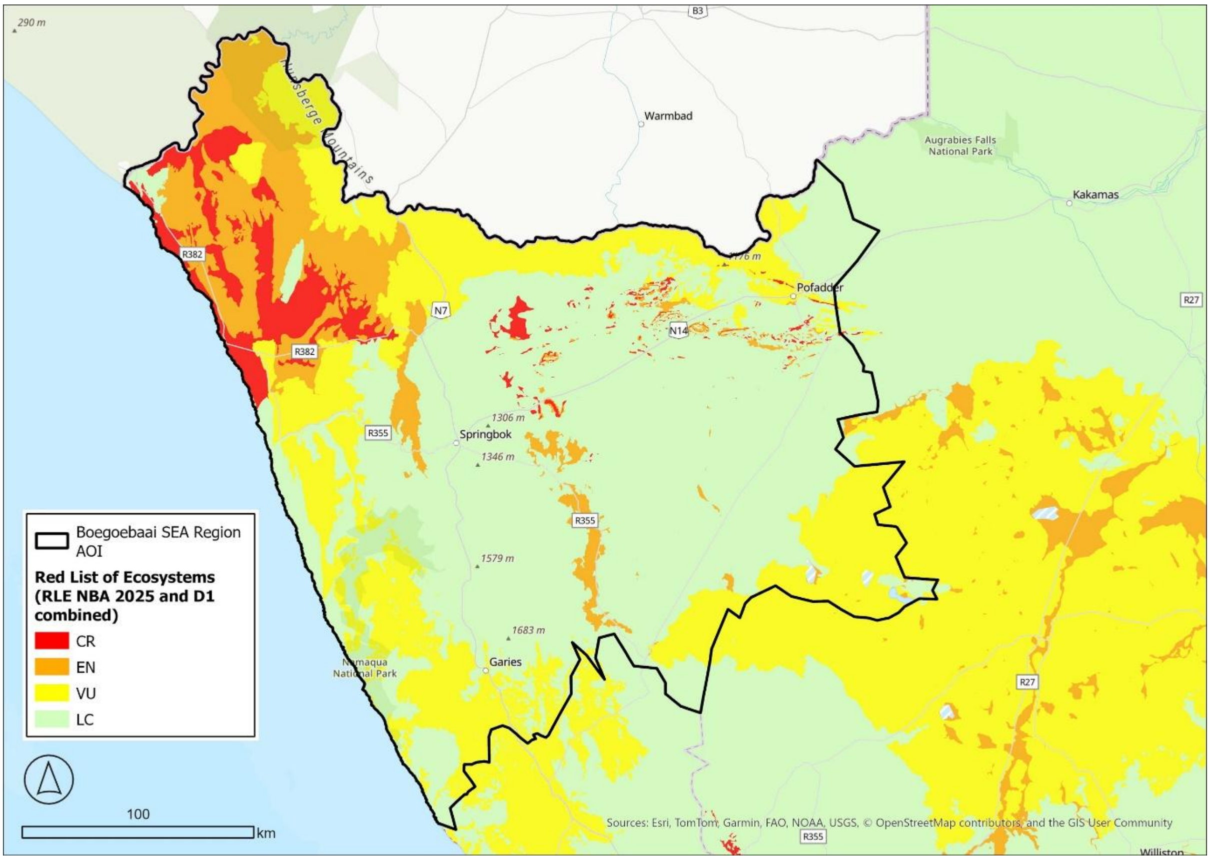


Figure 2-10: The combined NBA 2025 and D1 Red List of Ecosystems (RLE).

Table 2-6: The Red List of Ecosystems (RLE) status of vegetation types in the SEA region. The extent degraded the % of vegetation type area with negative EVI (<-25%) trend in both 2024 and 2018. Ecosystem Protection Level (EPL) value is WP = well protected, MP = mostly protected, PP = Partially protected and NP = Not protected.

Vegetation Type	Extent Degraded	RLE (D1)	RLE (NBA 2025)	EPL (NBA 2025)
Aggeneys Gravel Vygieveld	55,06	EN	LC	WP
Alexander Bay Coastal Duneveld	86,96	CR	CR	NP
Anenous Plateau Shrubland	32,34	VU	LC	NP
Blouputs Karroid Thornveld	0,71	LC	LC	WP
Bushmanland Arid Grassland East	0,83	LC	LC	PP
Bushmanland Arid Grassland West	3,82	LC	LC	PP
Bushmanland Basin Shrubland	45,47	VU	LC	PP
Bushmanland Inselberg Shrubland	82,43	CR	LC	PP
Bushmanland Sandy Grassland	0,91	LC	LC	NP
Bushmanland Vloere	50,07	EN	LC	PP
Central Richtersveld Mountain Shrubland	56,09	EN	LC	WP
Die Plate Succulent Shrubland	13,44	LC	LC	NP
Eastern Gariep Plains Desert	44,25	VU	LC	PP
Eastern Gariep Rocky Desert	36,76	VU	LC	NP
Eenriet Plains Succulent Shrubland	46,95	VU	LC	NP
Goariep Mountain Succulent Shrubland	41,46	VU	LC	WP

Vegetation Type	Extent Degraded	RLE (D1)	RLE (NBA 2025)	EPL (NBA 2025)
Hantam Karoo	14,85	LC	LC	NP
Helskloof Canyon Desert	25,15	LC	LC	WP
Kahams Mountain Desert	43,16	VU	LC	WP
Kamiesberg Granite Fynbos	5,17	LC	LC	NP
Kamiesberg Mountains Shrubland	8	LC	LC	NP
Kosiesberg Succulent Shrubland	65,18	EN	LC	NP
Kwaggarug Mountain Desert	45,66	VU	LC	WP
Lekkersing Succulent Shrubland	80,17	CR	LC	MP
Lower Gariep Alluvial Vegetation	9,54	LC	LC	PP
Lower Gariep Broken Veld	4,19	LC	LC	PP
Namaqualand Arid Grassland	2,08	LC	LC	WP
Namaqualand Blomveld	21,51	LC	LC	PP
Namaqualand Coastal Duneveld	9,88	LC	LC	MP
Namaqualand Granite Renosterveld	18,21	LC	LC	NP
Namaqualand Heuweltjie Strandveld	23,6	LC	LC	PP
Namaqualand Heuweltjieveld	42,69	VU	LC	PP
Namaqualand Inland Duneveld	22,35	LC	LC	PP
Namaqualand Klipkoppe Shrubland	22,48	LC	LC	PP
Namaqualand Riviere	17,76	LC	LC	PP
Namaqualand Sand Fynbos	20,8	LC	LC	PP
Namaqualand Seashore Vegetation	57,41	EN	CR	PP
Namaqualand Shale Shrubland	65,54	EN	LC	NP
Namaqualand Strandveld	30,74	VU	LC	PP
Namib Lichen Fields	14,17	LC	CR	WP
Namib Seashore Vegetation	77,78	EN	CR	NP
Noms Mountain Desert	52,05	EN	LC	WP
Northern Knersvlakte Vygieveld	1,78	LC	LC	MP
Northern Nababiepsberge Mountain Desert	43,26	VU	LC	NP
Northern Richtersveld Scorpionstailveld	58,5	EN	EN	WP
Northern Richtersveld Yellow Duneveld	53,32	EN	LC	NP
Oograbies Plains Sandy Grassland	51,19	EN	LC	NP
Platbakkies Succulent Shrubland	51,7	EN	LC	NP
Richtersberg Mountain Desert	30,16	VU	LC	WP
Richtersveld Coastal Duneveld	77,23	EN	CR	NP
Richtersveld Red Duneveld	49,66	EN	LC	NP
Richtersveld Sandy Coastal Scorpionstailveld	81,64	CR	LC	NP
Richtersveld Sheet Wash Desert	38,94	VU	LC	WP
Riethuis-Wallekraal Quartz Vygieveld	10,87	LC	LC	WP
Rooiberg Quartz Vygieveld	73,14	EN	LC	WP
Rosyntjieberg Succulent Shrubland	59,49	EN	LC	WP
Southern Nababiepsberge Mountain Desert	59,8	EN	LC	NP
Southern Namaqualand Quartzite Klipkoppe Shrubland	34,78	VU	LC	PP
Southern Richtersveld Inselberg Shrubland	58,29	EN	LC	NP
Southern Richtersveld Scorpionstailveld	62,43	EN	CR	NP

Vegetation Type	Extent Degraded	RLE (D1)	RLE (NBA 2025)	EPL (NBA 2025)
Southern Richtersveld Yellow Duneveld	67,65	EN	LC	NP
Stinkfonteinberge Eastern Apron Shrubland	60,88	EN	LC	WP
Stinkfonteinberge Quartzite Fynbos	54,29	EN	LC	WP
Tatasberg Mountain Succulent Shrubland	20,25	LC	LC	WP
Umdaus Mountains Succulent Shrubland	42,3	VU	LC	NP
Upper Annisvlakte Succulent Shrubland	6,53	LC	CR	MP
Vyftienmyl se Berge Succulent Shrubland	86,03	CR	LC	WP
Western Bushmanland Klipveld	22,9	LC	LC	NP
Western Gariep Hills Desert	66,99	EN	LC	PP
Western Gariep Lowland Desert	34,55	VU	CR	NP
Western Gariep Plains Desert	5,25	LC	LC	PP

2.3.2.3 Levels of Protection

Site-based biodiversity management efforts are among the most effective means to reduce global biodiversity loss with a well-designed and managed network of statutory protected areas being regarded as the most effective management tool for conserving biodiversity (DEA, 2008). Emanating from the recognition of the Succulent Karoo as a region of global biodiversity importance, there has been a dedicated effort to develop the protected area estate in the biome since the 1990's. This effort has proceeded together with the development of systematic conservation planning in South Africa. Therefore, all the current protected area expansion strategies across agencies and role players are informed by systematic planning and are implemented within the context of the National Protected Area Expansion Strategy. Thus, implementation is aligned across agencies and is striving to achieve a national set of biodiversity conservation targets in line with international best practice. Currently, South Africa is aiming to achieve the 30x30 target implying that by 2030 the protected area estate will cover 30% or more of the region.

Much of this effort is witnessed in the current protected area network (Figure 2-11). Currently protected areas cover less than 8% of the region (Table 2-7). Ecosystem Protection Level (EPL) is another headline indicator from the National Biodiversity Assessment that gives an indication of how well we are achieving our biodiversity conservation targets. EPL is the amount of each ecosystem represented within the protected area network relative to the conservation target for that ecosystem. Only 20 (28%) of the regions ecosystems are well protected) compared to 47 (66%) that are poorly or not protected (Figure 2-13, Table 2-6). Notwithstanding the massive strides in growing protected areas over the past three decades there is still a considerable way to go if we are to meet the 30x30 targets in the region.

With regards the extent of protected areas represented in Figure 2-11 and Table 2-7, these provide an approximate extent of the PA estate. The protected area estate is continually evolving due to additional of new areas and clarification of statutory status and boundaries of existing areas. Consequently, no one data source accurately reflects the entire *de facto* protected area estate. The data presented here is sourced from various datasets including the DFFE PACA database (https://www.dffe.gov.za/egis), SANBI National Biodiversity Assessment data (https://bgis.sanbi.org/Projects/Detail/221) and Leslie Hill succulent Karoo Trust (WWF) datasets. The objective of this section is to provide a narrative of the developing PA estate and not an accurate account of this estate. Therefore, there will be minor discrepancies between what is reported here and what is currently observed on the ground.

Table 2-7: A summary of the protected area estate in the Namakwa Region.

Protected Area Type	% of Namakwa Region
National Park – National Park	3,13%
National Park – Contractual Park	2,92%
Provincial Nature Reserve	0,89%
Nature Reserve Stewardship Programme	0,03%
Private Nature Reserve (ORDINANCE)	0,65%
Total PA	7,62%
World Heritage Site BUFFER only	3,80%
World Heritage Site CORE only	2,48%
Total PA and WHS	13,89%

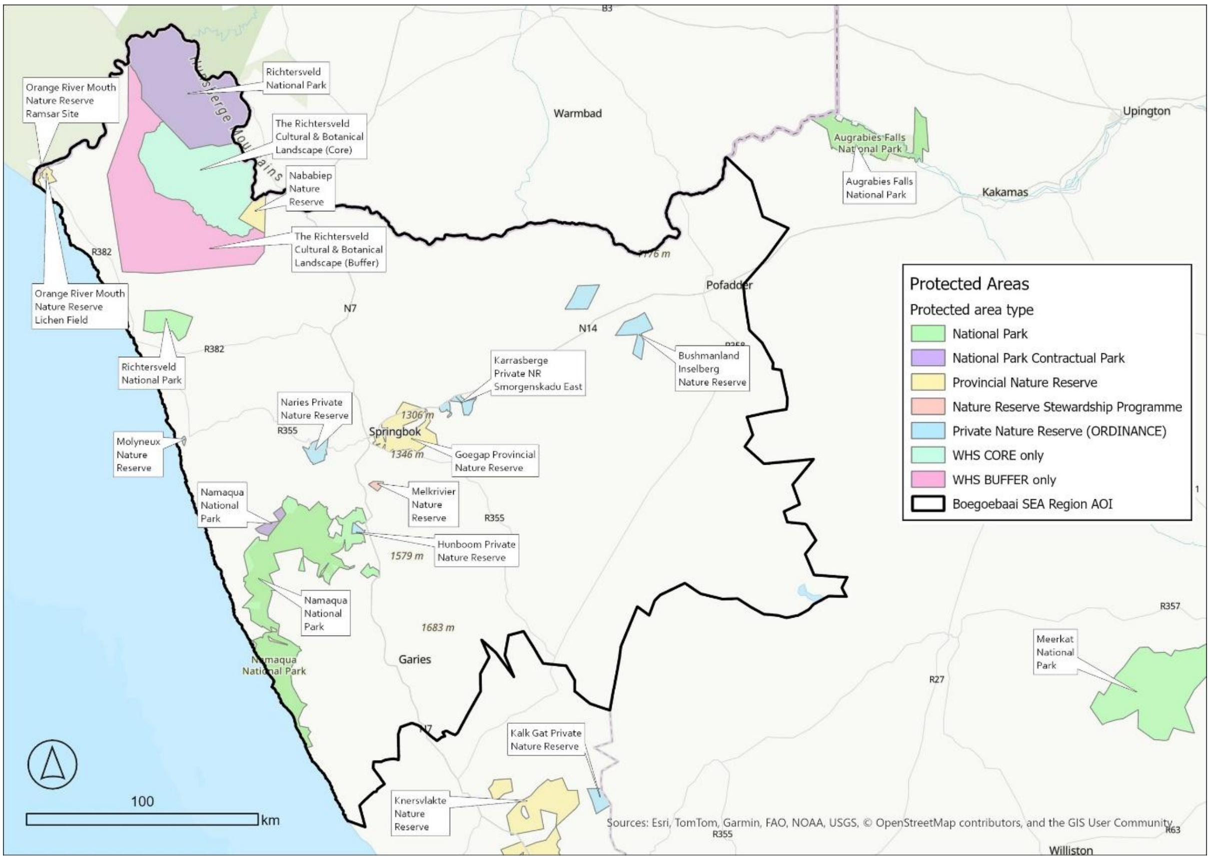


Figure 2-11: The approximate 2024 extent of protected areas in the Namakwa Region.

There are two state agencies responsible for developing the protected area estate in the region:

1. Northern Cape Department of Environmental and Nature Conservation (DENC) now Northern Cape Department of Agriculture, Environmental Affairs, Rural Development and Land Reform (DAERL)

2. South African National Park (SANParks)

Each of these agencies have their own protected area expansion strategies that are aligned to one another and with the National Protected Areas Expansion Strategy (NPAES), and more recently the SANParks 2040

Mega-Living Landscape vision. These agency plans provide the necessary spatial resolution for on-the-ground implementation of protected areas relative to the national PAES.

In the Namakwa Region these agencies are actively supported in their protected area expansion efforts by several NGOs. These include:

1. Leslie Hill Succulent Karoo Trust administered by WWF South Africa who has provided the bulk of funds with which to purchase properties for conservation.

2. Wilderness Foundation Africa working with landowners to signup stewardship sites.

3. The Nature Conservancy working with landowners to signup stewardship sites.

4. Conservation South Africa mostly stewardship with local communities.

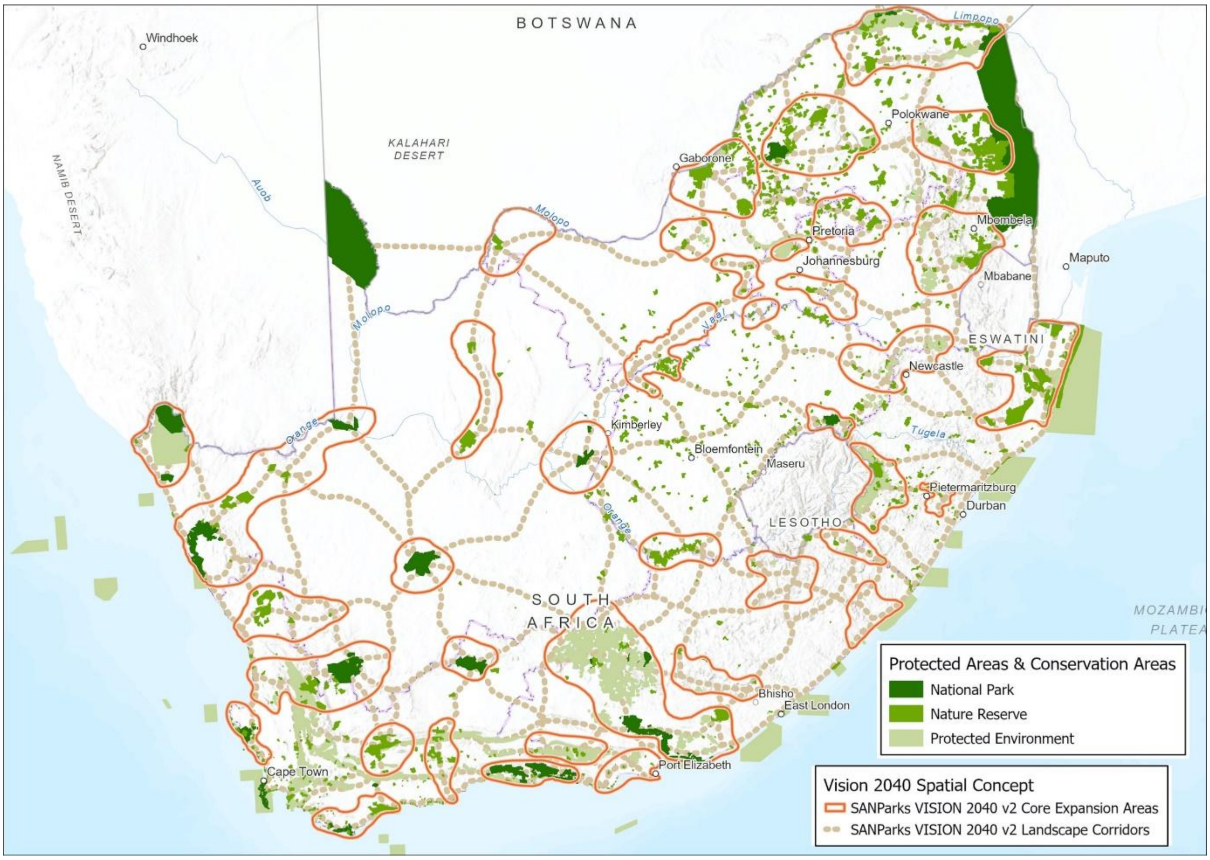


Figure 2-12: The Vision 2040 spatial concept summarising the mega-living landscape vision for protected area development in South Africa where core biodiversity conservation landscapes connected to each other via a network of landscape ecological corridors.

An important spatial planning concept currently informing all protected area development in South Africa is SANParks Vision 2040 (Figure 2-12). This vision proposes a much larger landscape-level vision for biodiversity conservation in South Africa. This national plan envisages a national network of mega-living landscapes / biodiversity economy landscapes centred around biodiversity conservation, people and biodiversity-based economic development. At the core of these landscapes are protected areas, and the linkages between these core areas give expression to the ecological process landscape linkages and climate change adaptation principles implemented in our spatial biodiversity plans. In the Namakwa Region there are two mega-living landscapes:

1. The Greater Richtersveld; and,

2. The Namaqualand Mega-Reserve that stretches from the Namaqua National Park on the coast inland to Augrabies Fall National Park.

A very important aspect of implementing a protected area expansion strategy is that it takes time. It happens slowly over time and not in one day. Sourcing funds, finding suitable properties and negotiating stewardship or purchase agreements all takes considerable time. Hence achieving a conservation vision for a protected area network can take decades to realise. Whilst we may have a good indication now of where we would like protected areas to develop in the future, it is vitally important in the short term to manage risk or likelihood of losing these areas to competing land use thereby compromising out conservation goals. This is where land use planning and particularly this SEA can help circumvent these conflicts from arising by planning to avoid target areas for conservation.

The current protected area expansion plans for the Namakwa Region when combined cover 72% of the region (Figure 2-14). In addition to the 2 mega-living landscapes, there are three core protected area development nodes in this map: Richtersveld, Namaqua National Park and Bushmanland Inselberg Region.

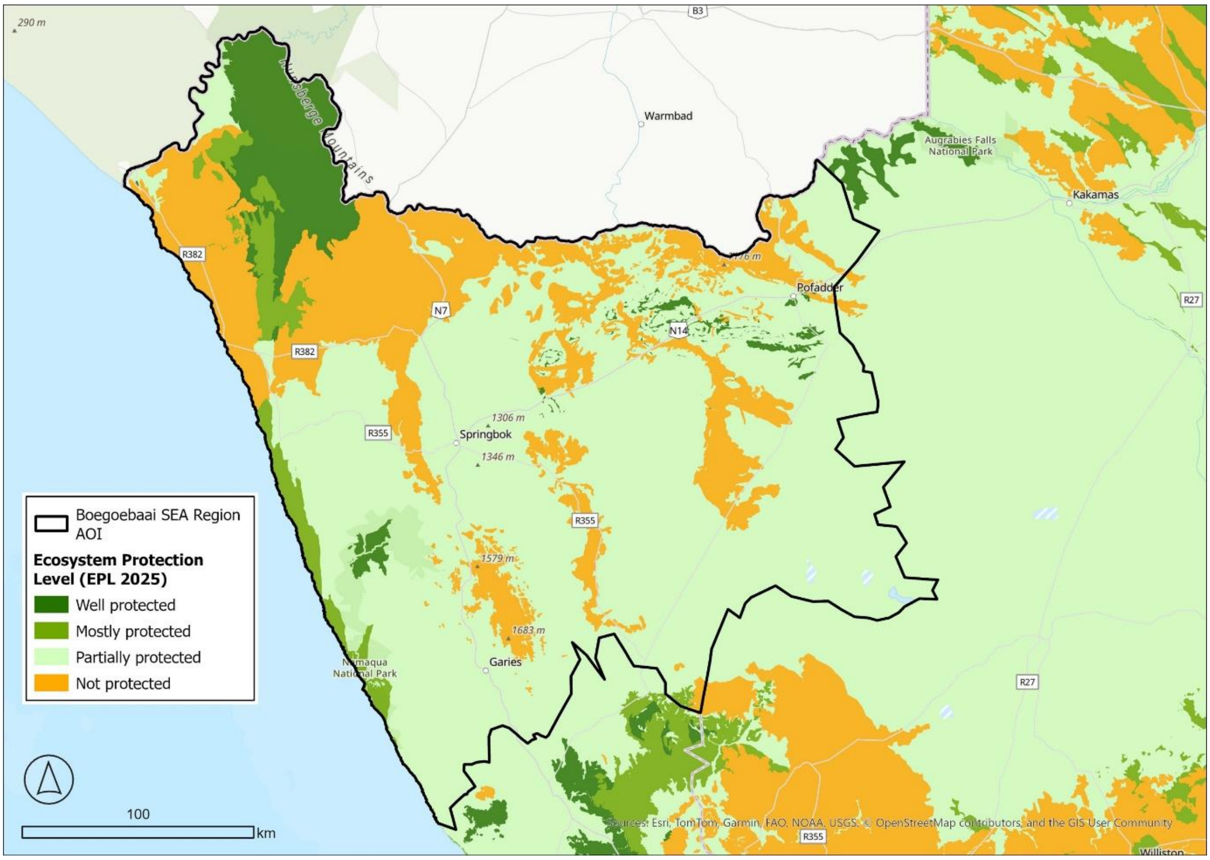


Figure 2-13: Ecosystem Protection Levels (EPL) for vegetation types in the SEA region.

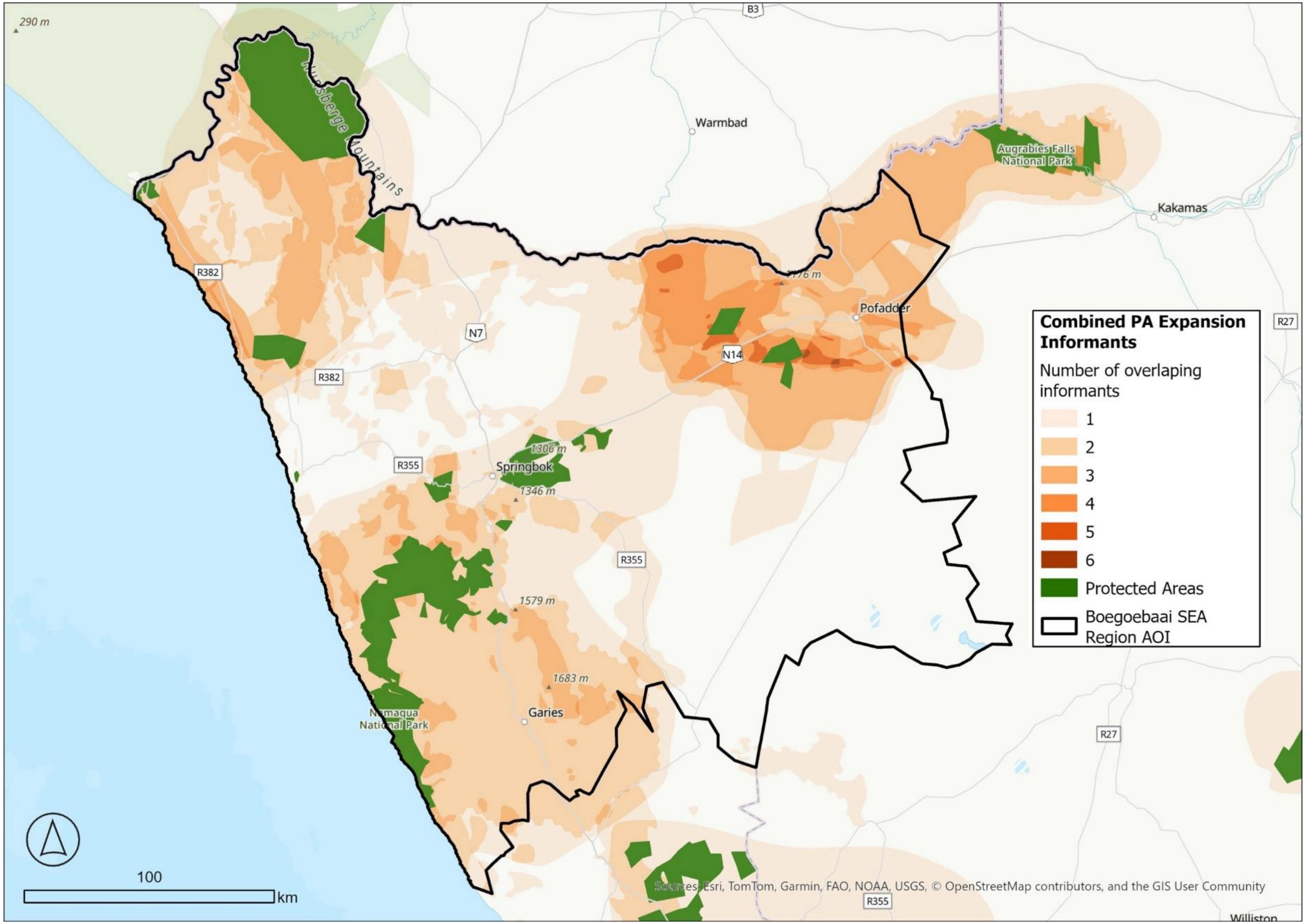


Figure 2-14: The combined protected area expansion focus areas for the Namakwa Region.

2.4 BIODIVERSITY SENSITIVITY ANALYSIS

To provide a perspective on known biodiversity sensitives, existing biodiversity planning informants and biodiversity sensitivity assessments conducted as part of this SEA process are integrated into a single regional **biodiversity sensitivity map**. There is a wealth of biodiversity-related datasets for the region that provide insights to the relative importance or sensitivity of the receiving environment and deciding on which datasets should be used to inform planning is non-trivial. Also, biodiversity sensitives for different components of biodiversity (e.g. plants vs birds vs animals) are not correlated across the region such that a sensitive area for one group will not necessarily reflect spatial sensitivities for other groups. It is therefore prudent and necessary to combine all available datasets into a single integrated sensitivity map for the region rather than attempting to select subset with which to assess the relative biodiversity sensitives of areas. This section briefly summarises the available informants and describes how these are combined to product an integrated biodiversity sensitivity map for the WP2 region.

In South Africa, there is a well-developed framework for incorporating biodiversity into land use planning and decision making in the form of Bioregional Plans. The maps of critical biodiversity areas and ecological support areas, referred to as a CBA Map, associated with these plans provide a standardised set of biodiversity importance values (CBA map categories) with which to assess the impact of land use planning and development decisions. Bioregional plans prepared for a region use a systematic conservation planning approach to develop a map with areas being earmark as important or necessary to achieve our national conservation goals (DEA, 2009). An advantage of CBA maps is that the production of these maps follows a standardised approach across all regions in South Africa that adheres to a set of national technical guidelines (SANBI, 2017). The biodiversity spatial planning products form the first group of informants included in the sensitivity assessment.

A second group of informants is provided by protected area expansion plans. The WP2 region is in the Succulent Karoo biome, a global biodiversity hotspot and as such the biodiversity economy is viewed as an important economic driver with biodiversity conservation and the development of the region's protected area network (PAN) forming the cornerstone of this economy. Nationally, the National Protected Area Expansion Strategy (NPAES) (DEA, 2016) is the national-level policy framework guiding protected area development within the provinces. On-the-ground protected area implementation is guided by provincial, regional or local-level protected area expansion strategies or development plans produced by the statutory agencies or conservation NGOs that identify in more detail specific areas earmarked for inclusion in the PAN. These plans provide another important source of biodiversity sensitivity information as industrial-type development is mostly not compatible with protected area development either directly through loss of areas within the expansion zone or indirectly such as through pollution of viewsheds or disruption of ecological processes (e.g. loss of corridors) adjacent to and between these PAN development zones.

A third group of informants is provided by the specialist studies group (birds, bats, animals and aquatic) sensitivity analyses conducted as part of the SEA process. Each of these assessments provide an interpretation of biodiversity sensitives with specific reference to the specialist group in question. Most of the data used in these assessments has not been used to inform bioregional plans or protected area expansion strategies and therefore this data compliments the above informants.

The following section describes these biodiversity sensitivity informants in more detail. Step one of the analysis process involved combining the raw data inputs to create 4-class high-low sensitivity maps where the resultant map depicts the maximum value from of inputs. This resulted in six sensitivity maps: group 1 biodiversity planning, group 2 protected area expansion, and group 3 specialist studies sensitivity (birds, animals, bats and aquatic ecosystems). Step two of the analysis combined these six intermediate sensitivity maps into a single biodiversity sensitivity map that depicts the combined sensitivity ranks of the inputs and also ranks based on the maximum of inputs.

2.4.1 Biodiversity Sensitivity Informants Group 1: Biodiversity Planning

Available biodiversity spatial planning informants are combined into a single biodiversity planning sensitivity map (Figure 2-15. Datasets informing this map are described in the sections that follow. The technical details on how inputs datasets are combined to create the 4-class high-low map are described in Appendix 2 Biodiversity Sensitivity Analysis Technical Notes.

In the combined biodiversity planning sensitivity map, the extent of high to very-high sensitivity categories cover 50% of the region, and medium to very-high covers 71% of the region (Table 2-9). This is very much to be expected as this is a global biodiversity hotspot and is in keeping with our understanding of the unique patterns of diversity that we see in this landscape. Generally, in South Africa CBA Maps earmark up in the region of 60% of the landscape as CBA and ESA.

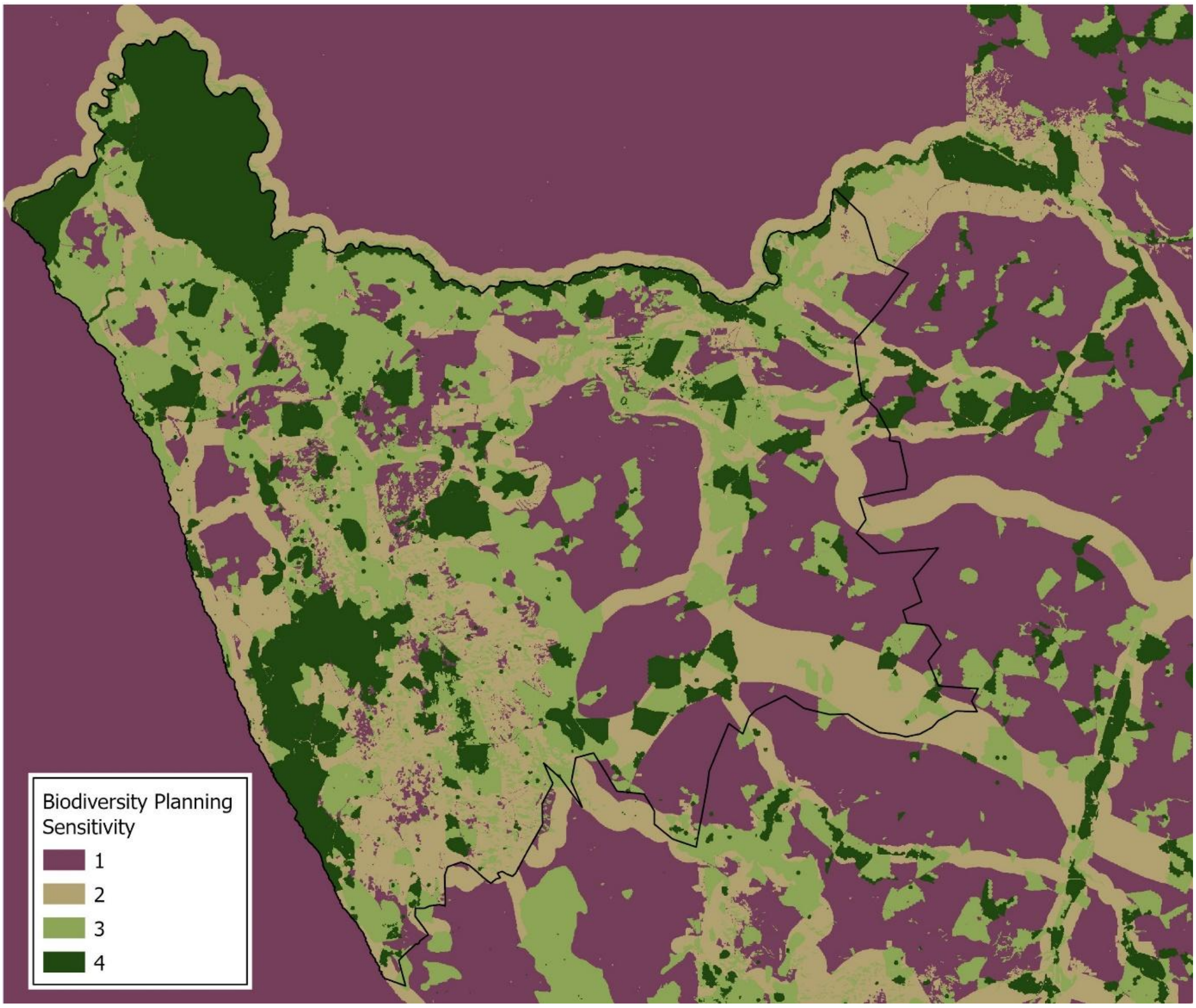


Figure 2-15: Map of combined biodiversity spatial planning sensitives. Sensitivity categories are 1=low, 2=medium, 3=high and 4=very high.

Table 2-8: An interpretation of what the biodiversity planning sensitivity map categories mean in terms of biodiversity importance and land use planning. The binary code is used in step two of the analysis to combine the six intermediate sensitivity maps into the overall biodiversity sensitivity map.

Sensitivity Rank	Map Code	Binary Code	Description
Very High	4	1000	Declared protected areas and conservation areas
Very High	4	1000	Irreplaceable sites. These are sites that are mandatory if we are to achieve our conservation goals targets. These are areas that contain extremely sensitive features, such as key habitat for rare, endemic or threatened species, or features that perform critical ecological functions. These sites are irreplaceable (i.e., no ecologically equivalent sites exist and there is no exchangeability between sites) or contain the necessary habitat to support the continued survival of species of conservation concern. Extensive GH2 activities should be avoided in these areas, as impacts of GH2 in these areas would undermine the ecological integrity of the region and our ability to achieve our conservation goals. Ideally these areas should be secured through appropriate zoning (e.g., CBA map, SDF), development controls, or protected area expansion.
High	3	100	Important and necessary sites. A selection of available sites that collectively contribute and meet a conservation goal or target. Areas that contain highly sensitive features and/or features that are important for achieving targets for representing biodiversity and/or maintaining ecological processes. These areas

Sensitivity Rank	Map Code	Binary Code	Description
			represent the optimal configuration for securing the species, ecosystems and ecological processes of the Karoo. Impacts of GH2 in these areas are undesirable, and any impact would need to be offset and ecologically equivalent sites identified to represent the same suite of biodiversity features that were impacted.
Moderate	2	10	Areas necessary to maintain ecological processes. Areas containing natural or semi-natural areas identified as being important for maintaining ecological processes such as the area required to main populations (e.g., foraging areas), protected populations from impacts (e.g., buffer zones) or to connect parts of the landscape (i.e., ecological corridor network). Any GH2 activity that has the potential to reduce habitat quality or lead to fragmentation of habitat through the loss of habitat or erection of barriers to species movement should be avoided and where unavoidable, then offset and strongly mitigated.
Low	1	1	Other areas of natural habitat not earmarked for achieving a biodiversity conservation outcome. These are areas that do not contain currently known sensitive or important features and are not required for meeting targets for representing biodiversity or maintaining ecological processes. Provided that category 2-4 areas are secured, loss of habitat here should not compromise our ability to achieve conservation targets provided the impacts here do not extend into adjacent areas of higher importance or sensitivity. If development is extensive, then offsets may still apply. However, if any impacts occur in category 2 and 3 areas, additional sites from this category may be required as alternatives for representing biodiversity and maintaining ecological processes. *Note that this category also includes areas that are no longer natural, however, this category is not indicated on the map.*

Table 2-9: Summary of the extent of categories in the biodiversity planning sensitivity map.

	Biodiversity Sensitivity Category	% of Namakwa Region
4	Very High (protected areas)	9,7
4	Very high	11,4
3	High	28.4
	Total area of 3 and 4	**49,5**
2	Medium	21.8
	Total area of 2, 3 and 4	**71,2**
1	Low	28,8
	Total	**100**

2.4.1.1 Northern Cape Critical Biodiversity Areas 2024

Maps of Criticval Biodiversity Areas and Ecological Support Areas, or CBA Maps, are spatial plans for conserving biodiversity and maintaining a well-functioning landscape or seascape (SANBI 2017). They show priority areas for retaining ecosystems and species and maintaining ecological functioning. CBA Maps are developed using scientific methods that combine a wide range of biodiversity data into one map that shows the most important places for biodiversity. The development of CBA maps gives effect to the requirements of the National Environment Management Act (NEMA) 107 of 1998 that obligates all organs of state to take biodiversity considerations into account and to ensure decisions are informed by the most up to date information. The Biodiversity Act (10 of 2004) provides for the management and conservation of biological diversity in South Africa and has introduced several tools to help achieve this. One of these tools is the development and publishing of bioregional plans (DEA, 2009). Bioregional plans inform land-use planning, environmental authorisations and natural resource management outside of protected areas. The bioregional plan serves as the primary source of biodiversity information informing land-use planning and decision-making processes. SANBI has developed a set of national guidelines for developing bioregional plans (SANBI 2017).

The 2024 Northern Cape Critical Biodiversity Area Map (Figure 2-16, Oosthuysen and Geldenhuys 2024) builds on previous biodiversity spatial plans in the province. This 2024 version is the first revision of the original 2016 provincial CBA Map. An artefact of this provincial-scale CBA Map is the relatively coarse spatial resolution of the plan, something that proves limiting for on-the-ground site-level applications. Also, the nuances of finer-scale biodiversity plans are lost at this coarser resolution. A third aspect of the provincial is that it uses rivers and mountain ranges as a spatial surrogates for ecological corridors and not a designed ecological corridor network. Within the context of landscape-wide development proposals identifying and retaining landscape ecological connectivity is an essential mitigation activity. Therefore, for this SEA assessment the provincial product is used in conjunction with other the finer-scale Namakwa District Municipality (NDM) Biodiversity Sector Plan.

2.4.1.2 Namakwa District Biodiversity Sector Plan 2009

The Namakwa District Biodiversity Sector Plan (http://bgis.sanbi.org/Projects/Detail/52, Marsh *et al.*, 2009, Figure 2-17) predates the development of the provincial CBA products. This plan covers the entire SEA area and has several attributes that complement the provincial product, namely, the finer spatial resolution, the inclusions of datasets not used in the provincial plan, and the inclusion of a designed, albeit expert mapped, ecological corridor network.

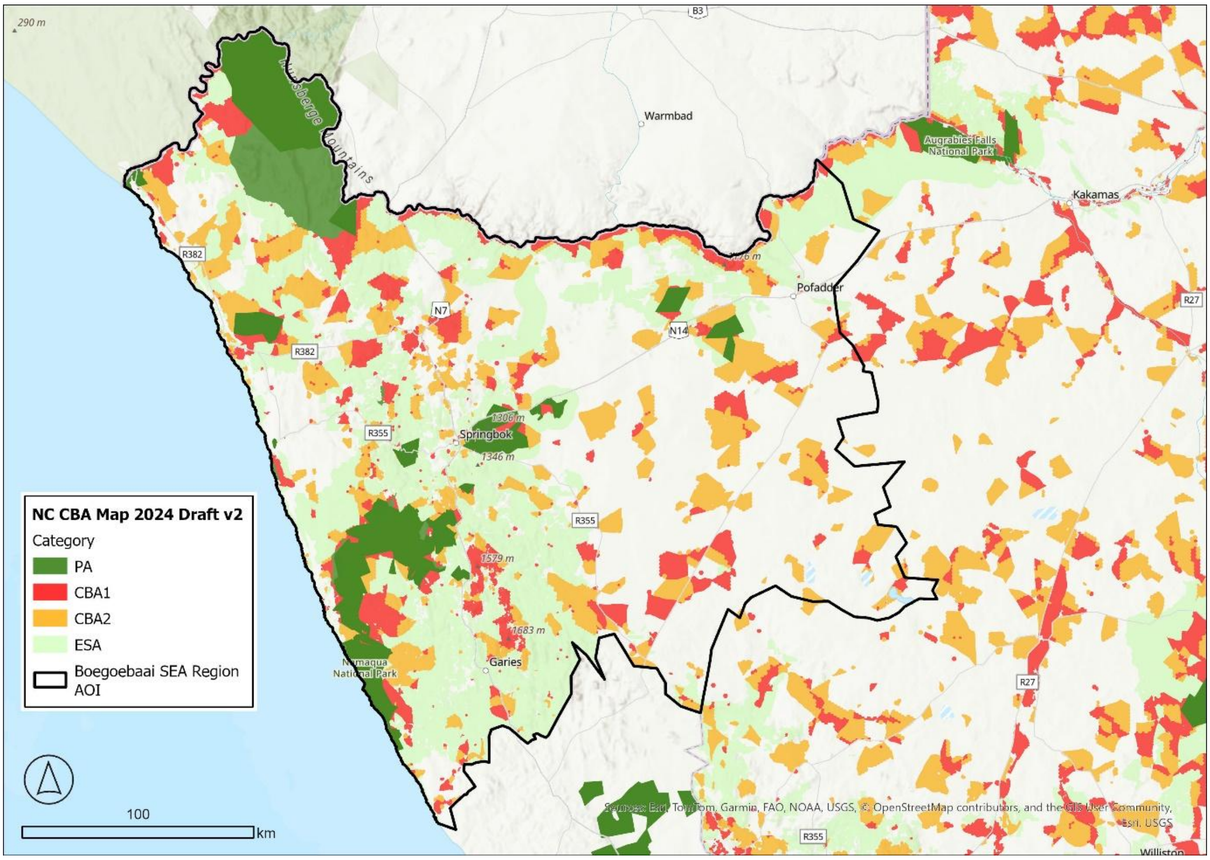


Figure 2-16: The Northern Cape Map of Critical Biodiversity Areas and Ecological Support Areas (2024 Draft v2, Oosthuysen and Geldenhuys 2024).

2.4.1.3 Plants Species of Conservation Concern

Plant species of conservation concern (SCCs) include threatened and rare plants that have been assessed SANBI's Threatened Species Programme (http://redlist.sanbi.org). this point-locality data is used to provide a fine filter observation-based planning informant (Figure 2-18). Threatened plant species are already considered in the Northern Cape 2024 CBA Map, however, rare species are included here as they are also an important indicator of biodiversity sensitivity.

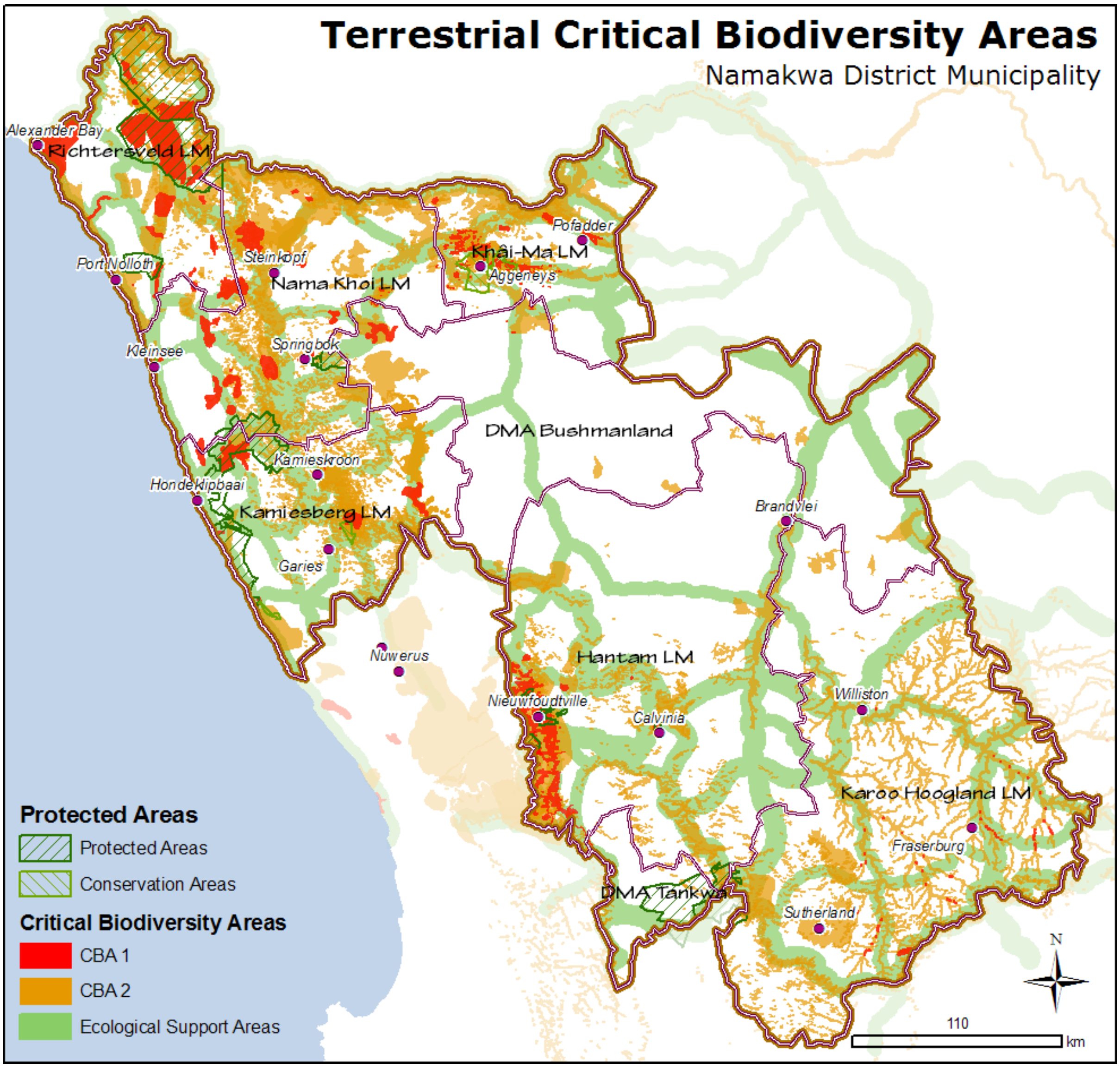


Figure 2-17: The Namakwa District Map of Critical Biodiversity Areas and Ecological Support Areas (map from Marsh et al. 2009).

2.4.1.4 Key Biodiversity Areas (KBAs)

Key Biodiversity Areas (Figure 2-19) are 'sites that contribute significantly to the global persistence of biodiversity', which means they are the most important places in the world for species and their habitats – whether these be in terrestrial, freshwater, estuarine or marine ecosystems. KBAs provide a global currency for identifying the most biologically significant sites, which helps focus our collective efforts on conserving the places that matter most. The KBA initiative is a global partnership to identify, map, monitor, and conserve areas to help safeguard the most critical sites for nature. SANBI and BirdLife South Africa lead this initiative in South Africa. South Africa re-assessed KBAs in 2017 becoming the first country to apply all 11 KBA criteria. In 2024, the KBA Secretariat approved 263 terrestrial KBA sites underpinned by 3598 species triggers and 309 ecosystem triggers. The large number of terrestrial sites that qualify as global KBAs demonstrates the megadiverse and rich heritage of South Africa. (https://www.sanbi.org/biodiversity/building-knowledge/biodiversity-monitoring-assessment/key-biodiversity-areas-in-south-africa/)

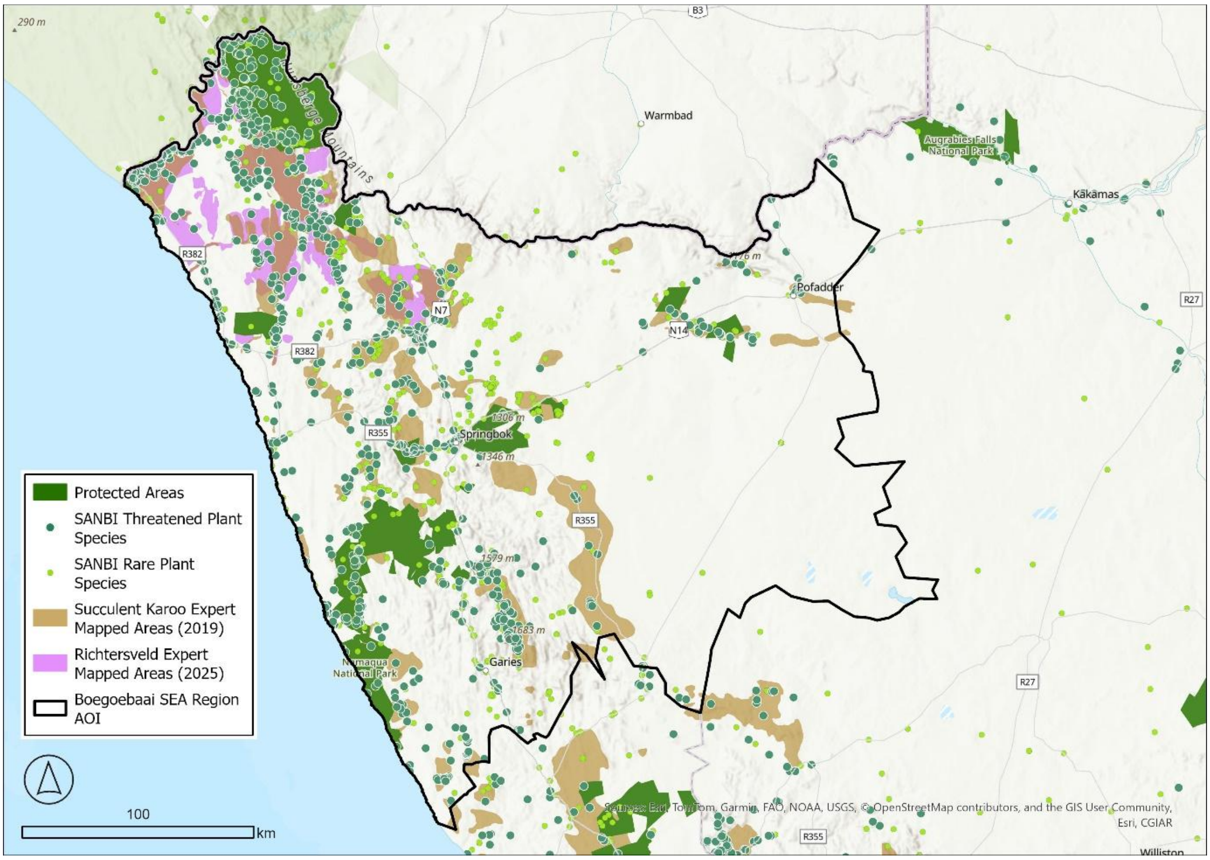


Figure 2-18: Expert mapped important areas for plants and SANBI species locality data.

KBAs are not use in this assessment. In the Namakwa Region there are 16 KBAs that cover 82% of the region. This large extent of KBAs viewed in context of the national KBAs network reiterates the global significance of the Greater Cape Floristic Region and the Namakwa Region as a global biodiversity hotspot. Whilst the KBAs are useful for focusing international attention on the Succulent Karoo and Namaqwa Region, the extensive coverage of KBAs mean that they have limited value for informing fine-scale or on-the-ground spatial planning and development decision making within the region. In this SEA analysis the Important Bird Area information is extracted from the KBAs data to compliments the bird sensitivity analysis (see following section).

2.4.1.5 Biodiversity Planning Sensitivity

Whilst the wealth of spatial planning informants provides useful tools for informing and guiding development planning, deciding on where to apply or how to interpret the various products can be a challenge. The inputs described above each provide different perspectives on biodiversity priorities or sensitivities based on the underlying information or approach used to identify areas. Thus, objective of this integration exercise is to combine the selected informants into a single map biodiversity sensitivity map (a) without necessarily re-interpreting the original results of the original studies, and (b) broadly keeping in line with the bioregional plan CBA Map framework that is the standard tool informing land use planning in South Africa. The CBA map and map categories are well understood in land use planning in South Africa, and it is therefore useful to keep within this framework of thinking for the integration of input. Whilst the integration approach aligns broadly with that used to develop CBA maps, the product is not intended to replace any existing CBA maps, therefore the resultant map should be interpreted as a map of biodiversity sensitivities (Table 2-8).

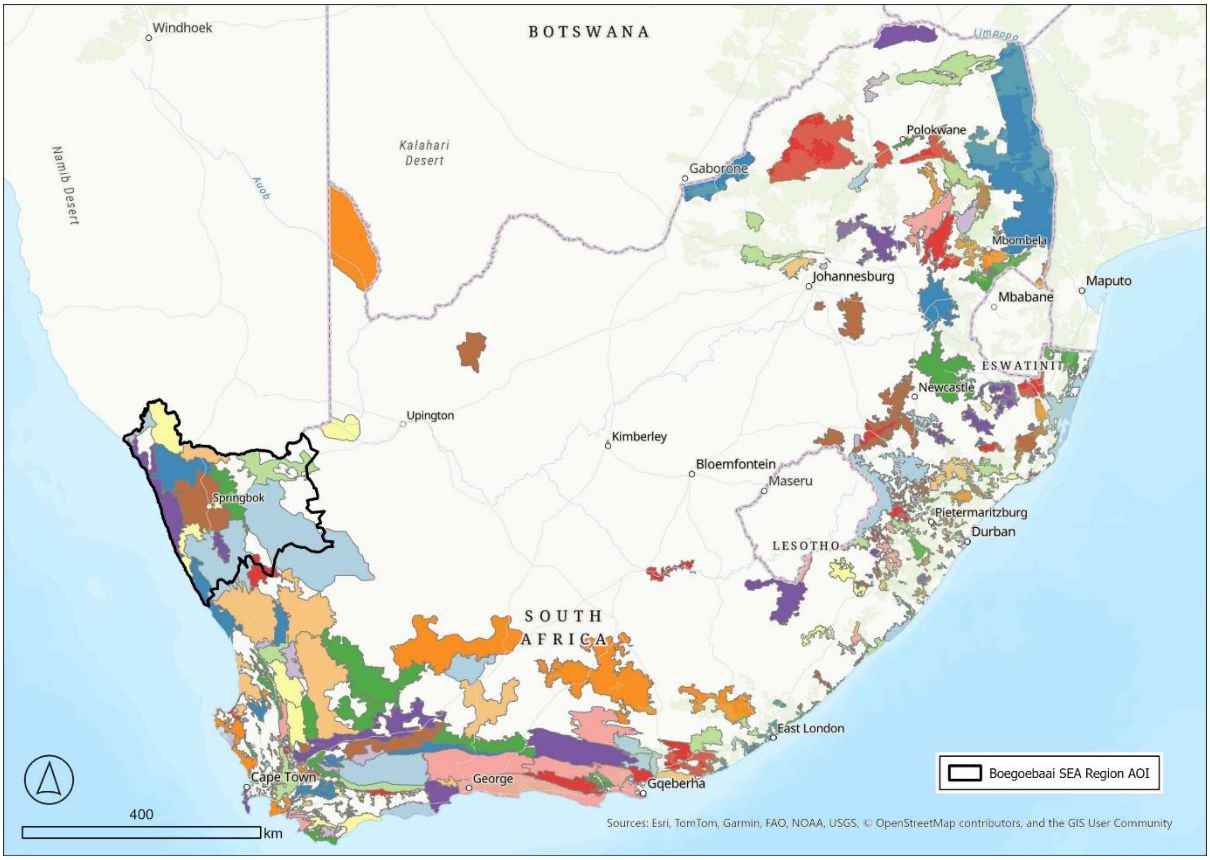


Figure 2-19: The extent of 16 the KBAs in the Namakwa Region in relation to the national network of 263 KBAs.

2.4.2 Biodiversity Sensitivity Informants Group 2: Protected Area Expansion Plans

The National Protected Area Expansion Strategy (NPAES) (DEA, 2016) is the national-level policy framework guiding protected area development within the provinces. It provides the necessary scientific, policy, and planning tools to ensure that protected area expansion contributes to sustainable development and international biodiversity commitments. The NPAES serves as a 20-year framework to accelerate the cost-effective expansion of protected areas. It aims to improve ecosystem representation, ecological sustainability, and climate change resilience by identifying priority areas, setting targets, and providing mechanisms for land-based and marine expansion. The primary focus is to protect a representative sample of all South Africa's ecosystems, particularly focusing on under-represented biomes such as grasslands, Nama Karoo, Succulent Karoo, and specific marine, river, and wetland ecosystems.

The strategy identifies 42 focus areas for land-based expansion, which are large, intact, and unfragmented areas suitable for protection. Whilst the NPAES is a spatial assessment it is not a protected area development plan in that it gives broad guidance as to protected area development spatial priorities across the country and it does not identify specific sites earmarked for inclusion in the PAN. At the level of this SEA it is more informative to consider local-level protected area development plans and other spatial plans that have been adopted by the agencies and NGO's that are being used for on-the-ground PAN development (Table 2-10, Figure 2-20). These informants were combined into a 4-class high-low sensitivity map where the sensitivity rating reflects the number of times a site is earmarked by the combined informants (Figure 2-21, Appendix 2 Biodiversity Sensitivity Analysis Technical Notes Biodiversity Sensitivity Analysis technical Notes).

Table 2-10: List of spatial inputs used to inform protected area expansion sensitivity.

	Name of Dataset	Source
1.	Northern Cape PAES 2017	Northern Cape DAERL
2.	Succulent Karoo expert mapped areas 2019	Leslie Hill Succulent Karoo Trust / WWF. Includes Richtersveld expert areas by Pieter van Wyk mapped as part of WP1. (See Appendix 3)
3.	KBA 2021 (IBA areas only) and IBA 2015	SANBI and Birdlife
4.	SANParks buffer zones 2025 and Augrabies Falls NP expansion plan 2025	SANParks
5.	SANParks Vision 2040	SANParks
6.	Bushmanland Protected Area Development Zone 2013	Bushmanland Conservation Initiative

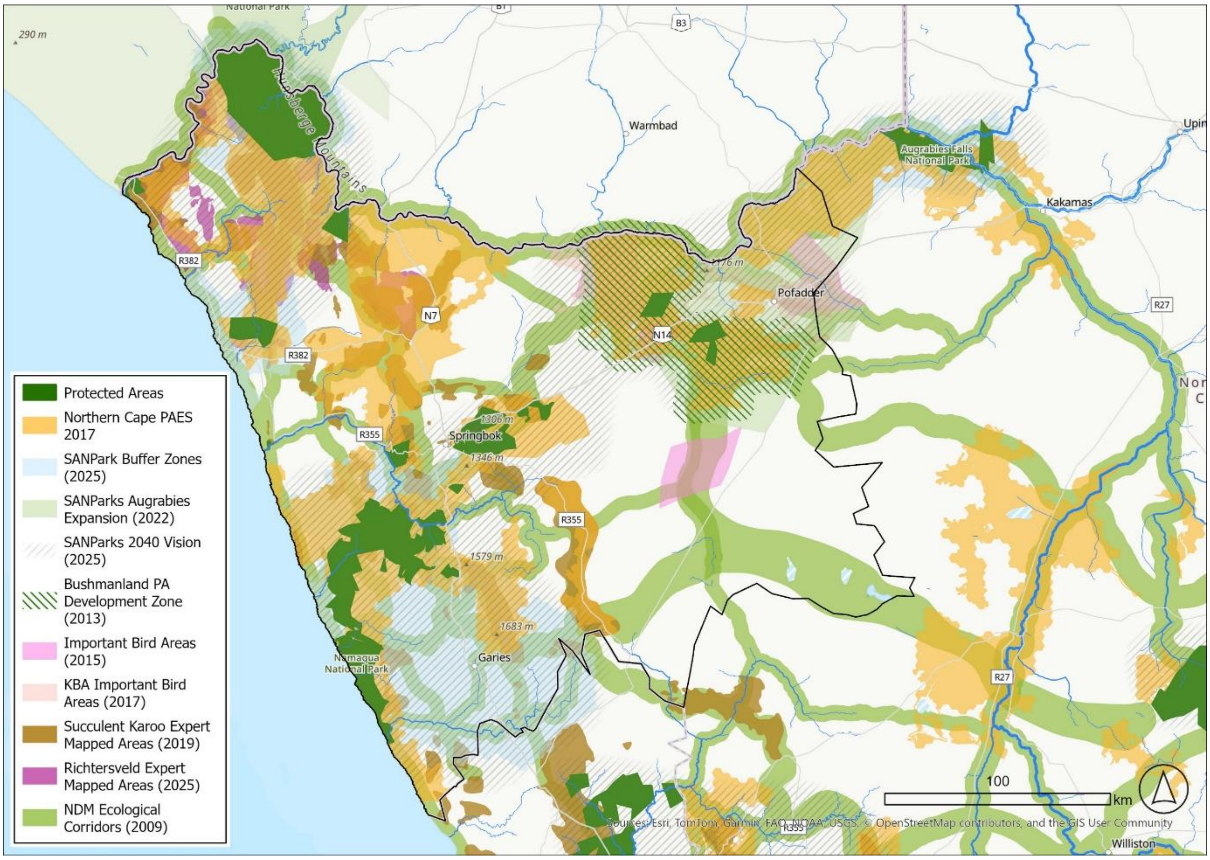


Figure 2-20: Inputs included in the protected area expansion sensitivity analysis. Note that the NDM corridor network is included here for context only. The ecological corridor network that links protected areas is included in the biodiversity planning analysis.

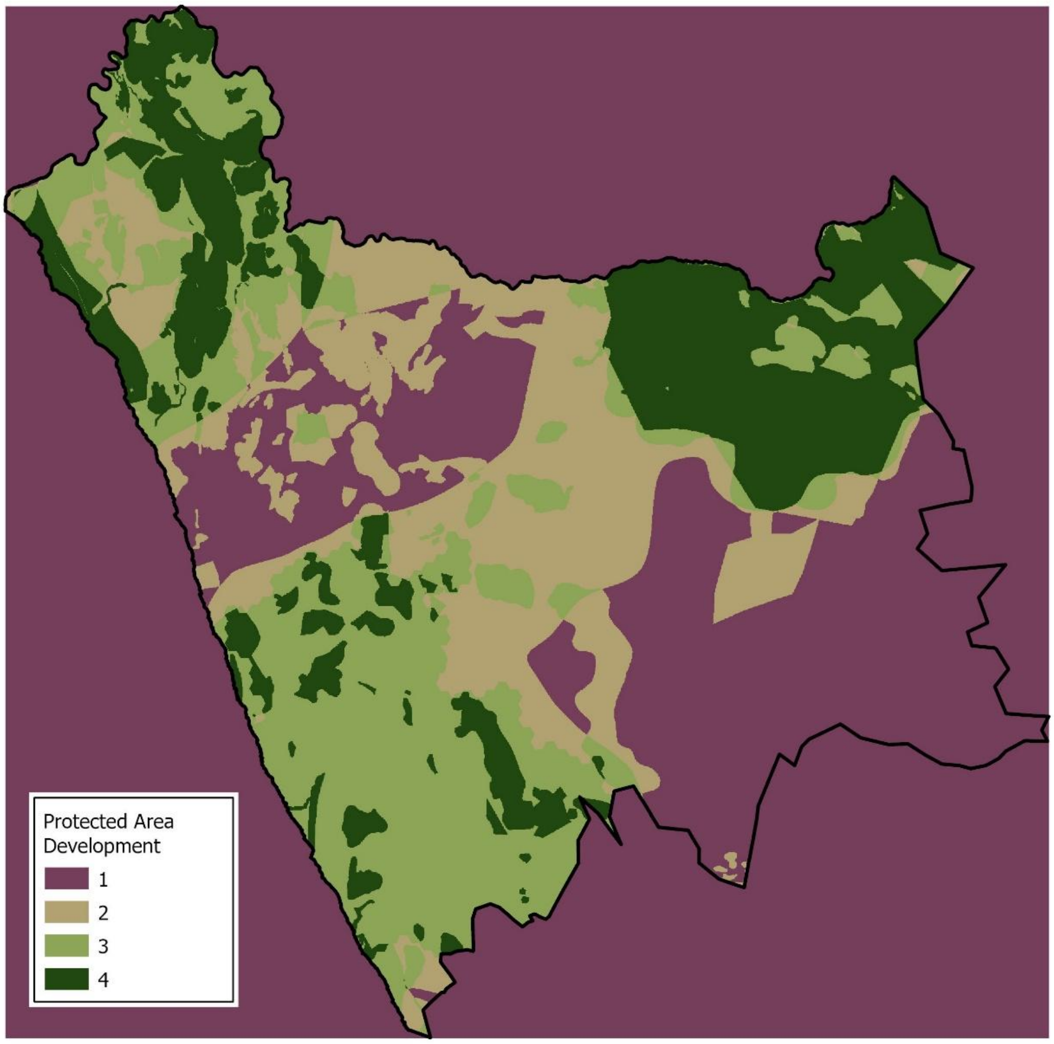


Figure 2-21: Map of protected area expansion sensitivities. Notes that this map does not include existing protected areas as these are already included in the biodiversity planning sensitivity map.

2.4.3 Biodiversity Sensitivity Informants Group 3: Specialist Assessments

As part of the SEA regional assessment, specialist studies were undertaken with each study conducting a sensitivity analysis that is relevant to the taxonomic group in question. These assessments, summarised below, are incorporated into the overall biodiversity sensitivity assessment.

2.4.3.1 Bird Sensitivity Assessment

Kellerman et al. 2026 developed a regional bird risk assessment as part of the SEA regional work package. This assessment considers the risks to avifauna from four key development impacts: (1) displacement due to disturbance from noise, lighting, and human activity; (2) habitat loss and fragmentation; (3) collisions with wind turbines and transmission lines; and (4) electrocutions from transmission lines. Multiyear bird atlas data, species distribution modelling, and habitat mapping is integrated in a weighted risk assessment for 44 bird species of conservation concern. The four input risk maps were combined to create the bird sensitivity map with the highest sensitivity category of the inputs (i.e. maximum of inputs) becoming the overall sensitivity value (Figure 2-23).

The bird spatial risk assessment identifies areas of relative threat to bird species in relation to specific development-related impacts. This assessment does not highlight important habitats or areas for birds based on contribution to achieving a conservation goal. Therefore, the bird risk maps cannot be compared to, for example, the CBA or KBA maps discussed above.

Currently, there is no systematic planning spatial product for birds that identifies important and necessary for areas for bird conservation such as critical habitats, minimum habitat requirements, breeding sites, flyways/corridors, etc. It is possible, however, to draw on the Important Bird Areas (IBAs) that are used as one of the triggers for a KBAs (Figure 2-22). IBAs provide some spatial resolution in terms if important bird habitats in the Namakwa Region. As birds of conservation concern in the arid zone of South Africa are relatively agnostic in terms of habitat preference, and range widely throughout the entire arid zone in response to seasons and rainfall events it is difficult to determine important and necessary areas for the arid zone avifauna. To consider the area and ecological requirements for birds more effectively in development planning it is necessary that this is done. This is an important recommendation from the Kellerman et al. (2026) regional risk assessment study is the motivation for improved spatial planning for birds.

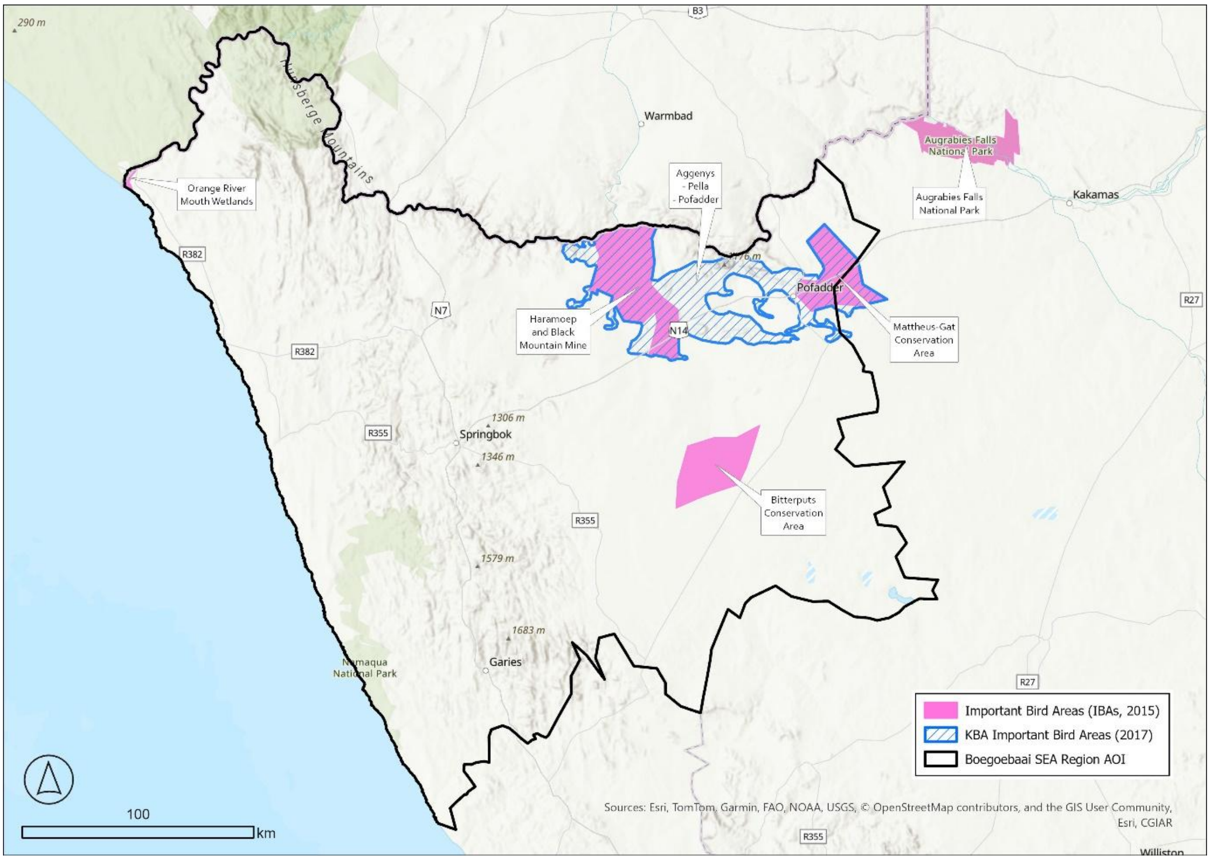


Figure 2-22: The extent of Important Bird Areas (IBAs) in the Namakwa Region.

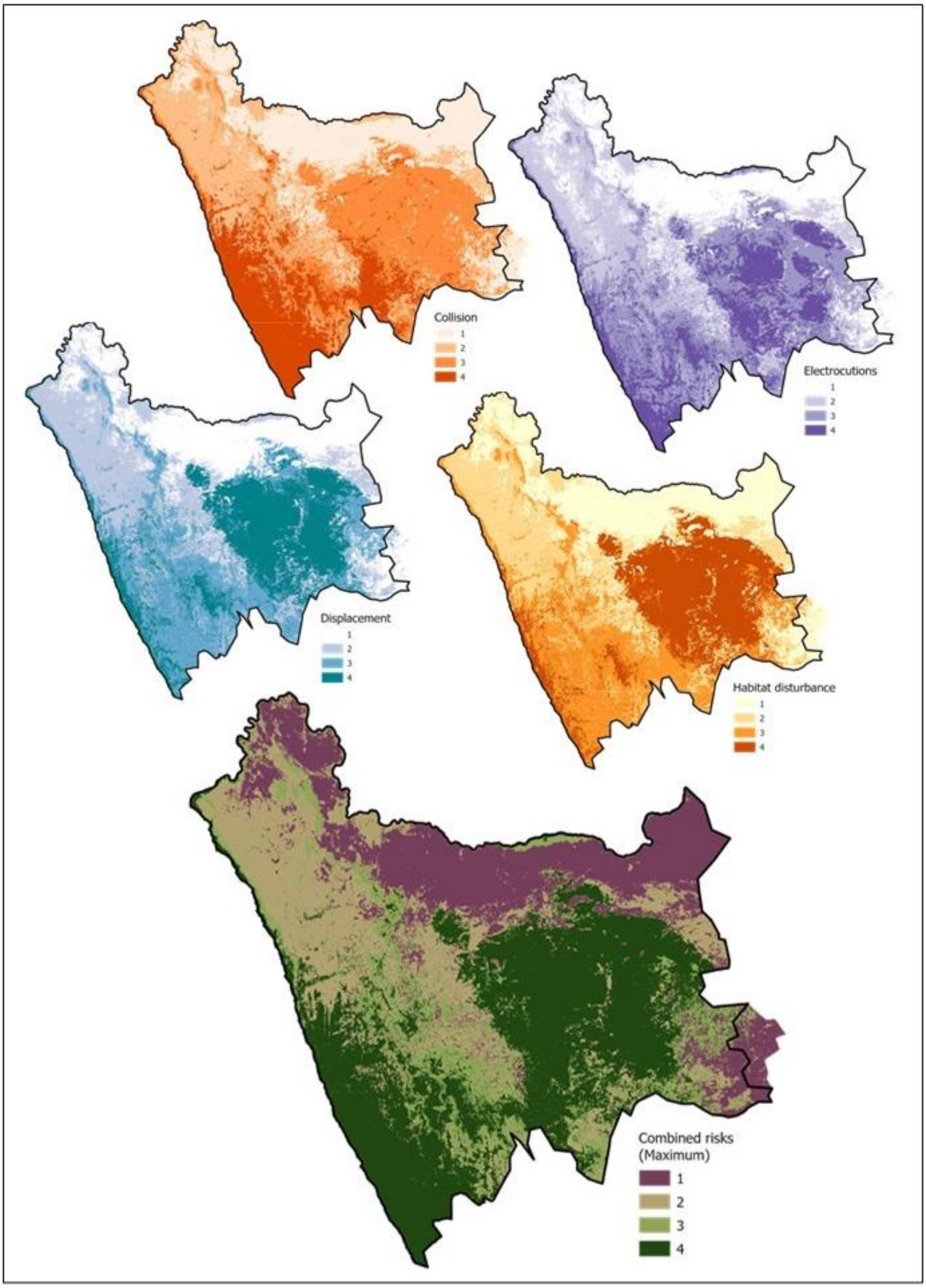


Figure 2-23: The regional bird risk (sensitivity) assessment in relation four key development impacts. The final sensitivity map combines the four individual layers with the maximum value from the four inputs becoming the final sensitivity value.

2.4.3.2 Bat Sensitivity Assessment

Werner and Welch (2026) developed a regional bat risk assessment as part of the SEA regional work package. The bat sensitivity analysis assesses the risk to bats populations to development based the relative importance of roosting, foraging, and conservation value areas (Figure 2-24):

- Very High sensitivity areas are characterised by exceptional roosting or foraging potential, very high levels of bat activity, and/or the possible presence of species of conservation concern (e.g., Vulnerable, Endangered, or Data Deficient). From a bat conservation perspective, such areas are generally unsuitable for development of GH2 and associated renewable energy because of the significant risks they pose to bat populations.

- High sensitivity areas include habitats with strong roosting or foraging potential and consistently high levels of bat activity. These areas are likely to present considerable risks to bats, and renewable energy development within them is generally discouraged.

- Medium sensitivity areas are associated with moderate roosting or foraging potential, moderate or uncertain levels of bat activity, and/or the potential presence of Near Threatened or Rare species. While development may be possible, site-specific assessments during the EIA phase of a renewable energy facility remain essential to confirm impacts and identify robust mitigation measures.

- Low sensitivity areas are characterised by limited roosting or foraging opportunities, low bat activity, and the absence of conservation-important species. These areas are considered more compatible with renewable energy development, though sensitivity mapping will still be refined at the EIA stage to confirm site-level risks.

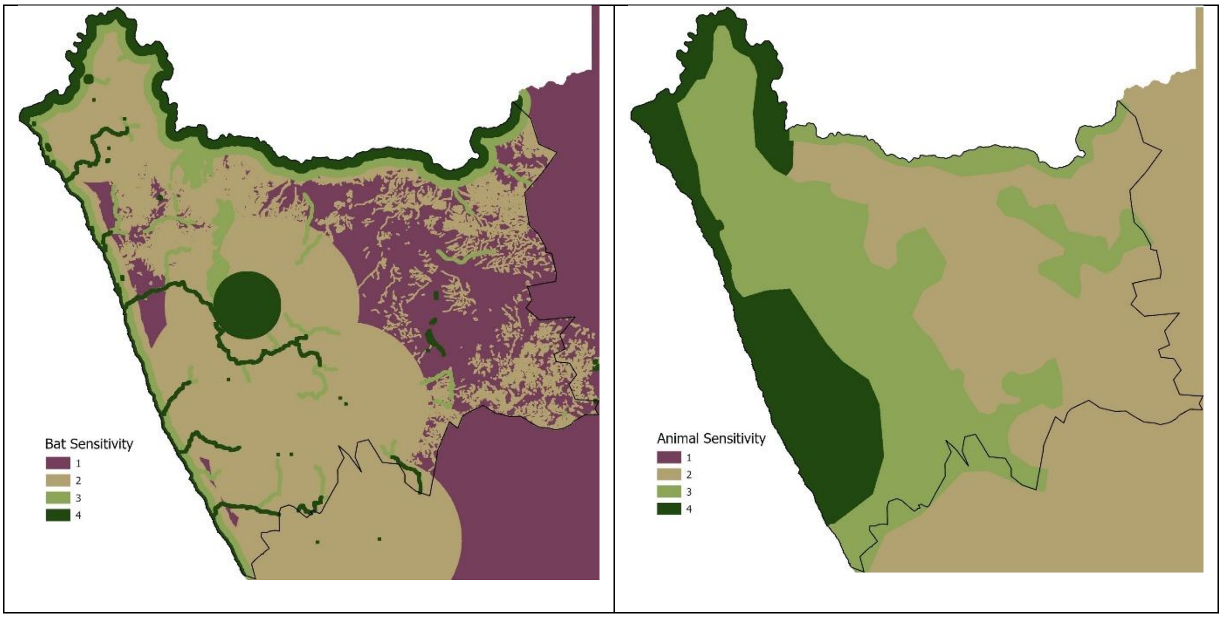


Figure 2-24: The regional sensitivity assessment for bats (left) and animals (right).

2.4.3.3 Animal Sensitivity Assessment

Niemandt (2026) developed a regional animal (fauna) risk assessment as part of the SEA regional work package. The faunal sensitivity of the Namakwa Region reflects the intersection of exceptional endemism, highly specialised habitat requirements, and intensifying development pressures characteristic of the Succulent Karoo biodiversity hotspot. The faunal sensitivity map is based on the distribution and relative importance of range-restricted, endemic, threatened, rare and habitat-dependent reptiles, amphibians, invertebrate and mammals Figure 2-24):

- **Very High Sensitivity** Areas predominately the coastal belt that coincides with the core habitat for several narrowly endemic and threatened species, particularly those associated with loose aeolian sands and fog-dependent dune ecosystems. Species include De Winton's golden mole (*Cryptochloris wintoni*, Critically Endangered), Grant's Golden Mole (*Eremitalpa granti granti*, Vulnerable), Desert rain frog (*Breviceps macrops*, Vulnerable (IUCN); Near Threatened (National)), Branch's rain frog (*Breviceps branchi*, narrow-endemic), and Namaqua dune mole-rat (*Bathyergus Janetta*, Uplisted to Endangered A4(a))

- **High Sensitivity** areas extend inland across Namaqualand Hardeveld, succulent shrublands, and rocky inselbergs, where important faunal species of conservation concern and ecological processes occur. Important species include Speckled padloper tortoise (*Chersobius signatus*, Endangered (IUCN)), Girdled lizards (*Namazonurus* and *Karusasaurus spp.*), Namaqua sand frog (*Tomopterna* branchi, Endemic). Important ecological processes underpinning High Sensitivity include high pollinator activity in flower-rich shrublands; soil engineering by ants, termites and rodents; seasonal amphibian breeding in natural pans; and, critical refugia on koppies for reptiles and small mammals.

- **Medium Sensitivity** areas cover much of the interior plains where faunal diversity, while still significant, comprise more disturbance-tolerant assemblages. These species have broader distributions in the region and have better tolerance of moderate habitat modification. Species include arid-zone toads, widespread sand lizards and skinks, mammalian generalists such as steenbok, hares and generalist rodents, and generalist invertebrate assemblages.

- No **Low Sensitivity** areas are identified.

2.4.3.4 Aquatic Sensitivity Assessment

Day *et al.* (2026) developed a regional aquatic risk assessment as part of the SEA regional work package. The aquatic assessment comprises three separate analyses each relating to a different spatial, physical and biological aquatic receptors. Only those components of the aquatic assessment that directly relate to biodiversity sensitivity have been included in this assessment, namely, the (1) surface water and (2) inland aquatic and estuary assessments. The groundwater sensitivity assessment is not considered here as no groundwater dependent ecosystems or species are specifically identified or discussed by Day *et al.* (2026).

Surface water sensitivity has been assessed for linear and distributed criteria. Linear features subject to impacts are the drainage network (river system) and the Orange River abstraction and reticulation network. Distributed features include aridity levels and the density of farm dams, all mapped at a quaternary level. These features are classified as follows:

- Very High sensitivity areas include the Orange River and buffer area, water supply reticulation pipeline from the Orange River and desalination plants, including towns they supply, or NFEPA river systems.

- High sensitivity areas include areas with more than 50 farm dams per quaternary, areas classified as arid, but with Aridity Index less than 10, or 1:50 000 rivers layer.

- Medium sensitivity areas include areas with fewer than 50 farm dams per quaternary, Aridity Index greater than 10, but in Arid classification (Aridity Index less than 20), or river buffers.

- Low sensitivity areas include areas classified as Hyper-Arid (Aridity Index greater than 20) or no surface water supply or storage.

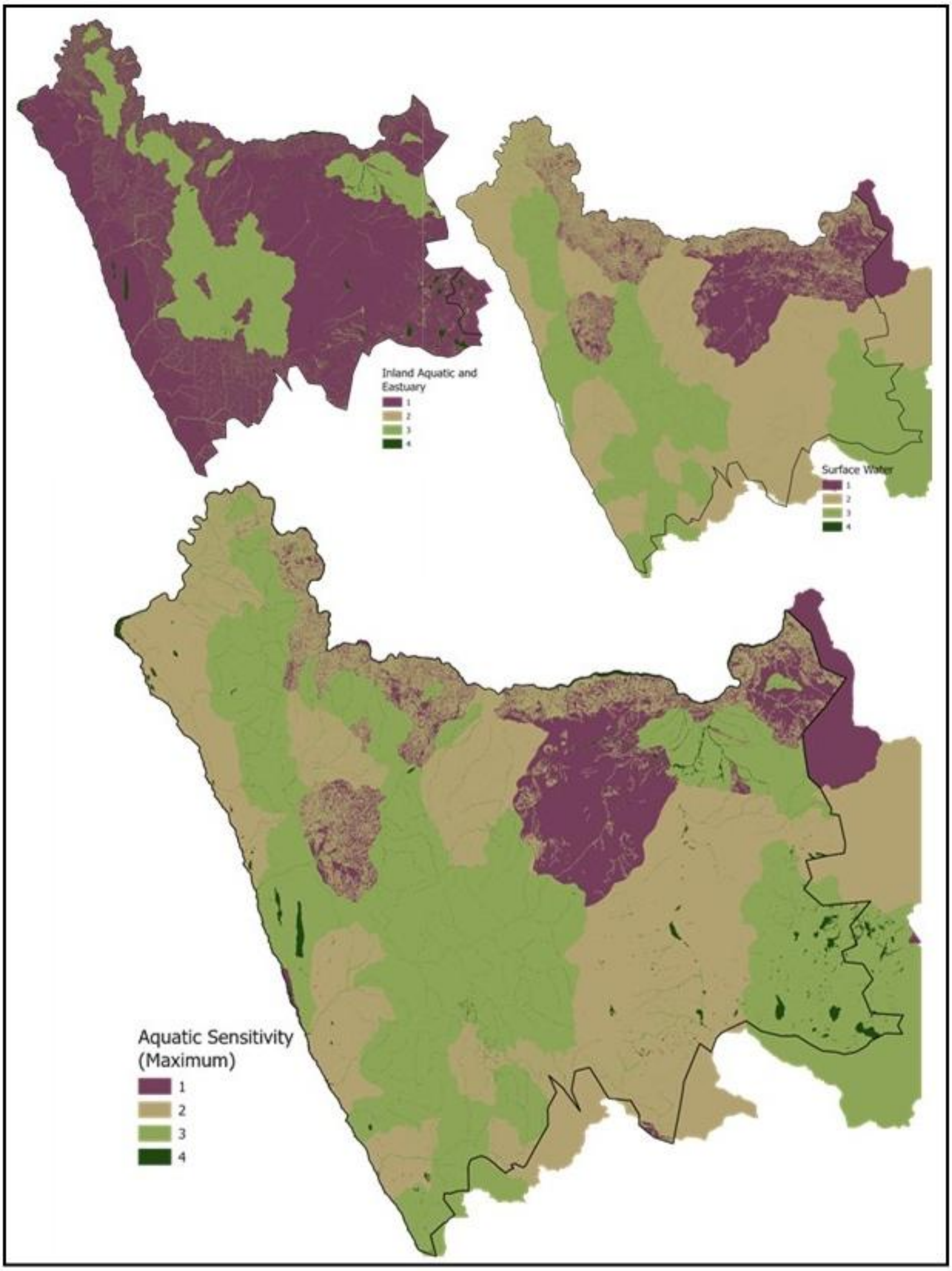


Figure 2-25: The aquatic sensitivity assessment in relation the input sensitivity assessments for surface water and inland aquatic and estuary aquatic receptors.

Aquatic ecosystem sensitivity classification considers inland aquatic and estuarine ecosystems in the context of their sensitivity in terms of (1) the capacity of an aquatic ecosystem to tolerate disturbance, and (2) the ecological importance of the impacted ecosystem.

- Very High sensitivity areas include NBA (2018) Critically Endangered (CR) and Endangered (EN) wetland types, CBA1 and CBA2 wetlands (NWM_5), NFEPA rivers, or Critically Endangered (CR) and Endangered (EN) estuaries (NWM-2).

- High sensitivity areas include all other wetlands included in the NWM 5, FEPA sub-catchments, upstream sub-catchments as identified in the NFEPA programme, all watercourses as mapped in 1:50 000 rivers layer and NFEPA river layer, artificial pans, dams, or all other estuaries (Estuary Functional Zones (EFZ)).

- Medium sensitivity areas include all watercourse buffers / development setback areas (20 m buffer round dams / artificial wetlands, 50 m buffer for 1:50 000 rivers, 50 m buffer for all wetlands, 100 m buffer for NFEPA rivers, EFZ data (NBA 2018)), or micro-outlets into the sea.

- Low sensitivity areas include all other areas not identified above, i.e. terrestrial areas outside of recommended aquatic ecosystem buffer zones.

The surface water and inland aquatic and estuary assessments were combined to create the aquatic sensitivity input with the higher sensitivity category of the two inputs (i.e. maximum of inputs) becoming the overall aquatic sensitivity value.

2.4.4 Integrating Sensitivity Informants

The six individual sensitivity maps described above (Figure 2-26) were equally weighted and combined to create a biodiversity sensitivity map for the SEA region using two integration approaches:

1 A maximum of inputs where the resultant rank is the maximum rank contained in the six inputs (Figure 2-27), and

2 Cumulation of inputs where the resultant numerical value is a binary code that reflects the combined sensitivity rank of all six inputs (Figure 2-28). For example, a combined rank code of 15 means that a site was ranked medium in one input and low in 5 inputs whereas a value of 1122 means a site was ranked very high by 1 input, high in another input, medium in 2 inputs and low in the remaining 2 inputs. The second approach of combining ranks provides a more nuanced integration of the inputs that gives greater spatial discrimination in the result.

The maximum of inputs sensitivity map (Figure 2-27) indicates that 70% of the region is ranked as very high sensitivity (Table 2-11). This is to be expected knowing that Namaqualand is a global biodiversity hotspot. Across almost the entire landscape it is expected that there will be high to very high biodiversity sensitivities in one form or the other.

In contrast the cumulated rank Figure 2-28 indicates that only 11.5% of the region is ranked very high for three or more of the inputs (Table 2-11). This indicates that there is some, but not a high degree of spatial correlation between the sensitivity inputs. In other words, areas important for plants are not necessarily also important for bats or birds. From the development perspective, this map illustrates where there might be more flexibility in the sensitivity map. For example, areas that are very high sensitivity for only one input implies that significant impacts may be lower and the required mitigation less than in an area that is very high for two or three inputs.

Table 2-11: Summary of the extent of biodiversity sensitivity categories in the SEA region. Sensitivity Rank 1 is a maximum of inputs. Sensitivity Rank 2 is a cumulation of inputs that gives an indication of how sites were ranked in the individual inputs.

RANK	% of Region	Cumulated Ranks Binary Code	Sensitivity Rank 1	% of Region	Area (ha)	Sensitivity Rank2	% of Region	Area (ha)
1	3.97	15, 24, 33, 42, 51, 60	Moderate	3.97	228 632	Low - Moderate	3.97	228 632
2	7.88	105, 114, 123, 132, 141, 150	High	26.19	1 508 282	Moderate - High	16.51	950 811
3	8.63	204, 213, 222, 231, 240						
4	5.44	303, 312, 321, 330				High	9.68	557 471
5	4.24	402, 411, 420, 501, 510, 600						
6	11.84	1014, 1023, 1032, 1041, 1050	Very High	69.85	4 022 084	High - Very High	58.33	3 359 224
7	27.95	1104, 1113, 1122, 1131, 1140, 1203, 1212, 1221, 1230, 1302, 1311, 1320, 1401, 1410, 1500						
8	18.54	2004, 2013, 2022, 2031, 2040, 2103, 2112, 2121, 2130, 2202, 2211, 2220, 2301, 2310, 2400						
9	8.95	3003, 3012, 3021, 3030, 3102, 3111, 3120, 3201, 3210, 3300				Very High	11.51	662 860
10	2.56	4002, 4011, 4020, 4101, 4110, 4200, 5001, 5010, 5100, 6000						
SEA Total Area (ha)				100	5 758 998		100	5 758 998

The sensitivity analysis is a pragmatic approach to combining a diverse array of datasets into a single map that gives insights on the relative sensitivity of areas in the SEA landscape. It must be remembered that it is a qualitative analysis that relies strongly on the opinion of the experts involved, the datasets available and how these are interpreted relative to the impacts envisaged. Whilst there is always room for improving input datasets (see recommendations) the current analysis is an integration of the best available information that is a "reasonably accurately" reflection of the major biodiversity sensitivities in the landscape.

Changing the assumptions behind the assessment could change or refine the spatial outcomes. This same analysis conducted for PV-only would provide a significantly different result due to the impacts of WEFs specifically on flying animals. Also, weighting sensitivities based on spatial flexibility in the underlying biodiversity feature (e.g. feature range of 10ha vs 100 000ha) or ability to mitigate risk (e.g. outright habitat loss vs degradation of habitat) would provide further insights on the spatial distribution of sensitivities. The current analysis does provide a good regional perspective on the spatial distribution of biodiversity sensitivities and where may be appropriate for large-scale RE developments. Further analysis will provide greater detail or resolution in parts of the map, but it is unlikely to change the broad spatial trends presented here.

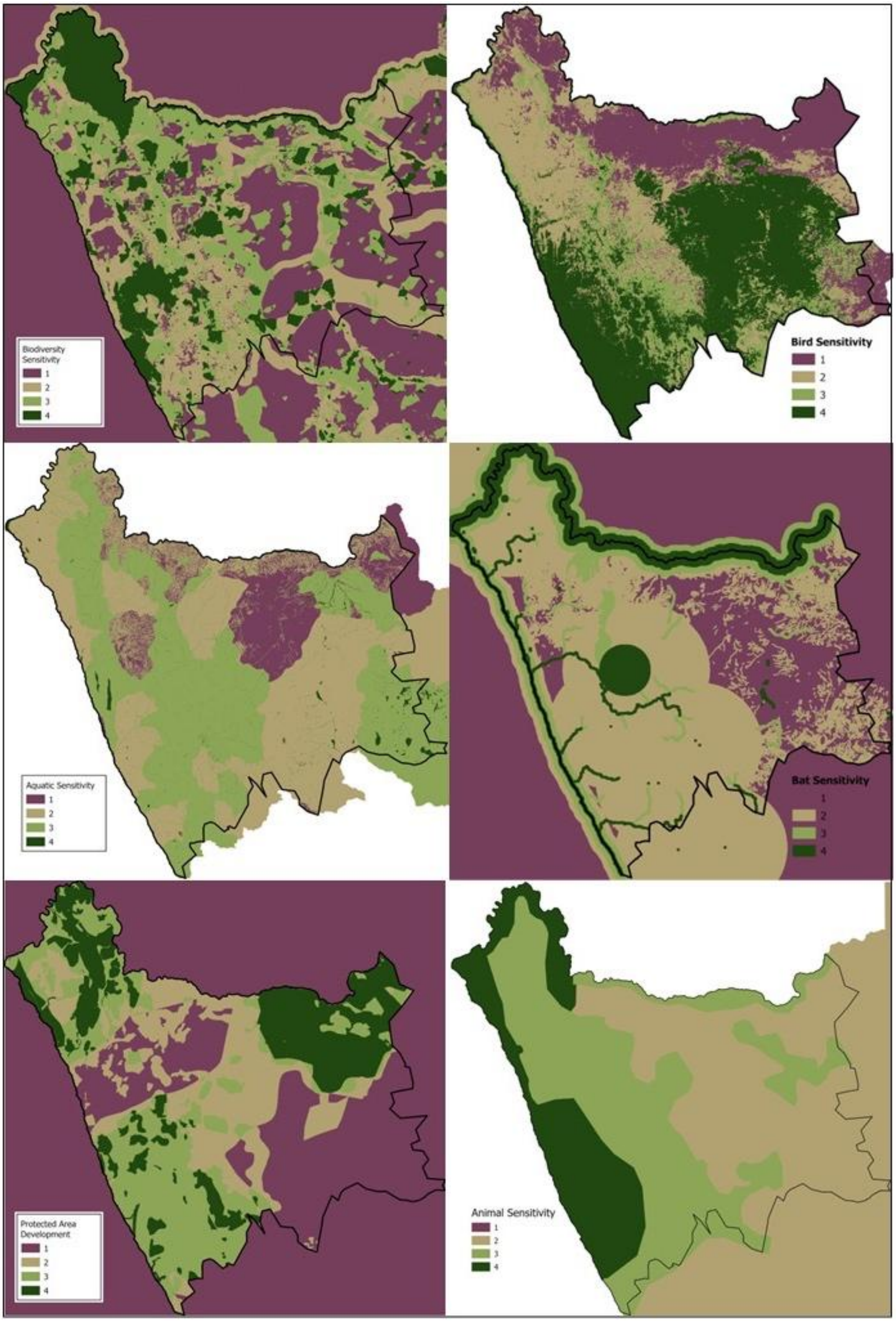


Figure 2-26: The six individual biodiversity sensitivity assessment inputs to the regional biodiversity sensitivity analysis.

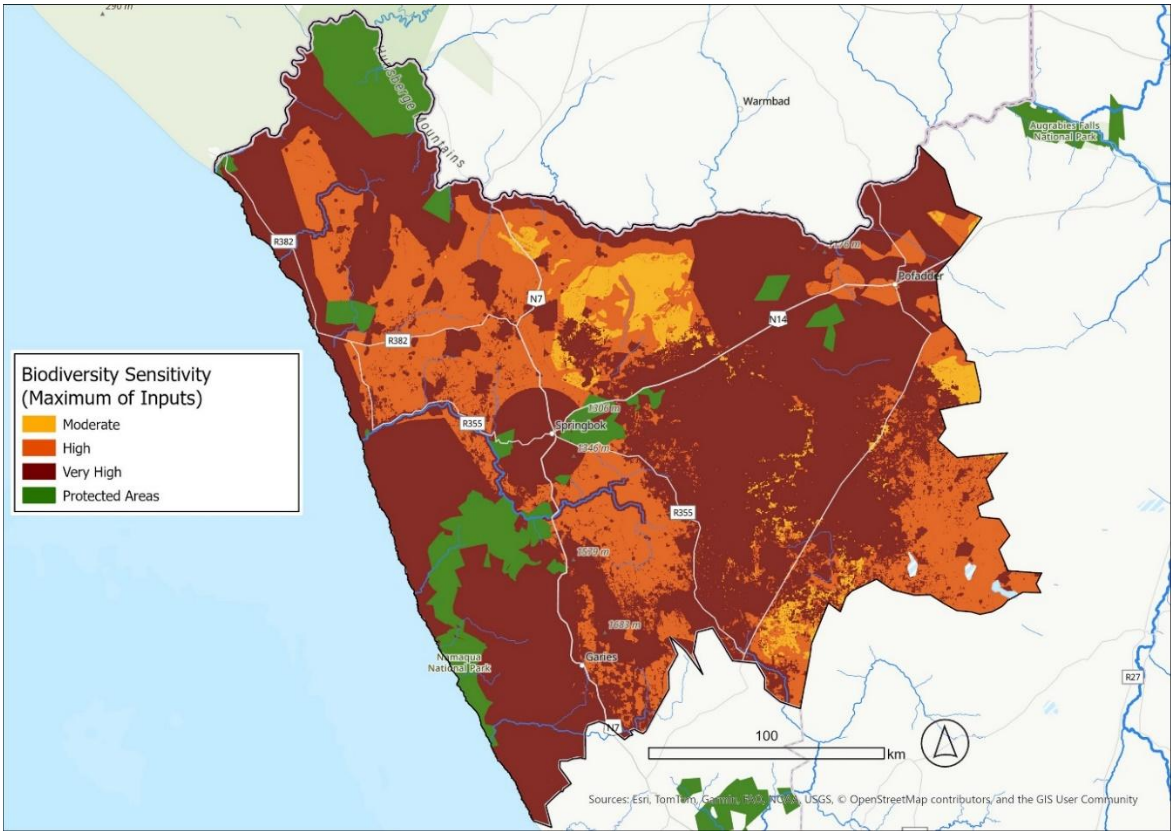


Figure 2-27: Biodiversity sensitivity rank for the SEA region based on the maximum of inputs.

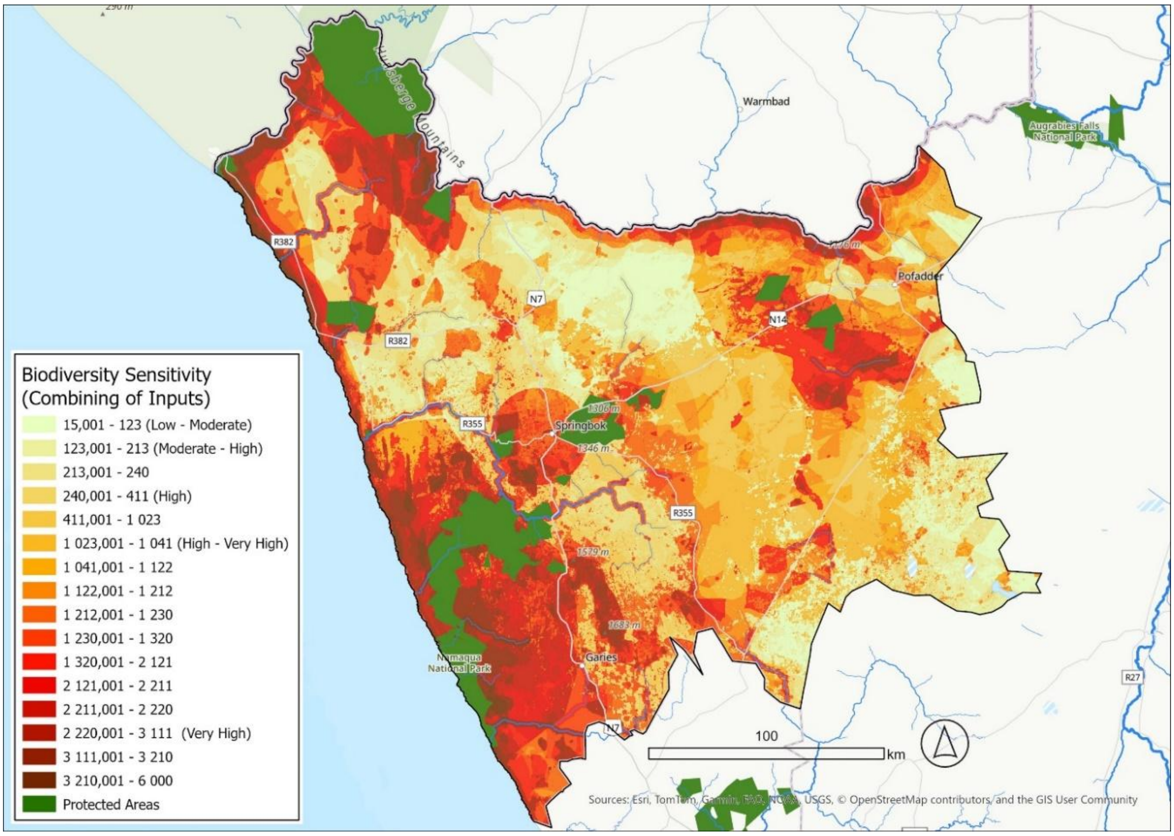


Figure 2-28: Biodiversity sensitivity rank for the SEA region based on the cumulation of inputs.

2.5 RISK ASSESSMENT

2.5.1 Definition of Consequence / Benefit Categories.

For biodiversity and ecological impacts (Table 2-12), risk is measured in terms of disruption of ecological processes, loss or degradation of ecosystems, and/or loss of species. The degree of risk (consequence) is assessed against thresholds for maintaining the functioning of all key ecological processes, maintaining a proportion of each ecosystem in good ecological condition, retaining all threatened species, and retaining a representative sample of all endemic or near-endemic species.

Whilst the regional assessment is aware of the total expected development footprint, there is no detail as to the location of the various development components under each scenario. So rather than attempting to articulate consequence in relation to the entire development scenario, it is considered at the site level in terms of what would the consequence be from a single development perspective. Therefore, thresholds of change are interpreted relative to a site and the consequence that the spatial scale of site-level impact would have on biodiversity in the landscape surrounding the site.

2.5.2 Description of Potential Impacts

Impacts of GH2 development at the regional scale are grouped into two high-level categories:

- Biodiversity pattern impacts. The immediate and direct loss of biodiversity due to the loss of habitat or species populations during the construction phase (e.g., land clearing) or operational phase (e.g., mortality of individuals). Primarily relevant in sensitivity categories 3 and 4.

- Ecological process impacts: The gradual and indirect loss of biodiversity due to the loss, disruption or degradation of ecological processes necessary for supporting species populations (e.g., construction of barriers to species movement, degradation of habitat due to light or noise pollution. Primarily relevant in sensitivity category 2.

2.5.3 Mitigation

There are a host of potential development- or site-specific mitigation actions. Some are discussed in relation to specific receptors in the species specialist regional reports. For the regional biodiversity assessment only high-level mitigation measures are considered in relation to the two high-level impacts considered. Mitigation measures include:

- Biodiversity pattern impacts:
    - Avoidance of development in sensitive landscapes (categories 2-4).
    - Where avoidance is not possible then safeguard regional biodiversity using biodiversity offsets to increase the extent of impacted ecosystems within formal protected areas.
- Ecological process impacts:
    - Avoidance of development in sensitive landscapes (categories 2-4).
    - Development type, site, ecosystem or species-specific mitigation measures to reduce disturbance, prevent imposition of impermeable barriers to movement and eliminate incidental death of individuals.

2.5.4 Risk Assessment Table

Given the spatial scale of both scenarios there is no difference in the assessed consequence and likelihood between with and without mitigation (Table 2-13). Whilst biodiversity offsets do guarantee that a portion of the biodiversity being lost is placed into formal protection, this does not negate the fact that a significant amount of biodiversity has been permanently lost. The only difference between with and without mitigation comes in the interpretation of the significance of this loss in relation to biodiversity sensitivity categories and their contribution to achieving our biodiversity conservation goals. Areas that that have been identified as being necessary to achieve our conservation goals for biodiversity pattern or ecological processes attract a higher risk rating.

A key aspect of the risk interpretation is the consideration of avoidance. As there is not guarantee that areas will be avoided the consequence and risk assessment is only considering mitigation without avoidance.

Table 2-12: Description of negative consequences as defined for biodiversity based on expert judgement. Consequence categories as per CSIR (2024) requirements.

Negative consequence	Impacts	
	Biodiversity pattern impacts	Ecological process impacts
Slight	• Loss of habitat over a contiguous area of <3ha • <20% reduction in the SEA regional extent of a SCC OR no reduction in size of the meta-populations (i.e., 0 out of 10 populations lost)	No disruption of ecological processes (<20%) • Longest dimension of cleared habitat: <300m • Length of impermeable barriers to species movement: <300m • Longest dimension of high-risk barriers to species movement: 0km • Length of boundary generating ecosystem degrading processes: <1km
Moderate	• Loss of habitat over a contiguous area of 3-10ha • 20-30% reduction in the SEA regional extent of a SCC OR reduction of no more than 10% in size of the meta-population (i.e., 1 out of 10 populations lost)	Some disruption of ecological processes (20-40% • Longest dimension of cleared habitat: 300-500m • Length of impermeable barriers to species movement: 300m-1km • Longest dimension of high-risk barriers to species movement: <300m • Length of boundary generating ecosystem degrading processes: 1-3km
Significant	• Loss of habitat over a contiguous area of 10-100 ha • 30-50% reduction in the SEA regional extent of a SCC OR reduction of no more than 30% in size of the meta-population (i.e., 3 out of 10 populations lost)	Significant disruption of ecological processes (40-60%) • Longest dimension of cleared habitat: 500m-750m • Length of impermeable barriers to species movement: 1-2.5km • Longest dimension of high-risk barriers to species movement: 300m-1km • Length of boundary generating ecosystem degrading processes: 3-5km
Drastic	• Loss of habitat over a contiguous area of 100-1000 ha • 50-80% reduction in the SEA regional extent of a SCC OR reduction of more than 50% in size of the meta-population (i.e., 5 out of 10 populations lost)	Very significant disruption of ecological processes (60-80%) • Longest dimension of cleared habitat: 750m-1km • Length of impermeable barriers to species movement: 2.5-5km • Longest dimension of high-risk barriers to species movement: 1-5km • Length of boundary generating ecosystem degrading processes: 5-10km
Extreme	• Loss of habitat over a contiguous area of 1000 ha or more • >80% reduction in the SEA regional extent of a SCC OR reduction of more than 80% in number of meta-populations (i.e., 8 out of 10 populations lost)	Highly significant disruption of ecological processes (>80%) • Longest dimension of cleared habitat: >1km • Length of impermeable barriers to species movement: >5km • Longest dimension of high-risk barriers to species movement: >5km • Length of boundary generating ecosystem degrading processes: >10km

Table 2-13: Assessment of risks associated with the negative impacts of GH2 on biodiversity. Risk with mitigation is assumed to be mitigation without avoidance.

Negative Impact	Scenario	Spatial receiving environment (Biodiversity sensitivity category)	Without mitigation			With mitigation		
			Consequence (-)	Likelihood	Risk	Consequence (-)	Likelihood	Risk
Biodiversity pattern impacts	S0: Baseline	4 Very High	Moderate	More Likely	MODERATE	Moderate	More Likely	MODERATE
	S1: Small GH_2		Drastic	Definite	VERY HIGH	Drastic	Definite	HIGH
	S2: Big GH_2		Extreme	Definite	VERY HIGH	Extreme	Definite	HIGH
	S0: Baseline	3 High	Moderate	More Likely	MODERATE	Moderate	More Likely	MODERATE
	S1: Small GH_2		Drastic	Definite	VERY HIGH	Drastic	Definite	HIGH
	S2: Big GH_2		Extreme	Definite	VERY HIGH	Extreme	Definite	HIGH
	S0: Baseline	2 Medium	Moderate	More Likely	MODERATE	Moderate	More Likely	LOW
	S1: Small GH_2		Drastic	Definite	HIGH	Drastic	Definite	MODERATE
	S2: Big GH_2		Extreme	Definite	VERY HIGH	Extreme	Definite	HIGH
	S0: Baseline	1 Low	Moderate	More Likely	MODERATE	Moderate	More Likely	LOW
	S1: Small GH_2		Drastic	Definite	HIGH	Drastic	Definite	MODERATE
	S2: Big GH_2		Extreme	Definite	VERY HIGH	Extreme	Definite	MODERATE

Negative Impact	Scenario	Spatial receiving environment (Biodiversity sensitivity category)	Without mitigation			With mitigation		
			Consequence (-)	Likelihood	Risk	Consequence (-)	Likelihood	Risk
Ecological process impacts	S0: Baseline	4 Very High	Moderate	More Likely	MODERATE	Moderate	More Likely	MODERATE
	S1: Small GH_2		Drastic	Definite	VERY HIGH	Drastic	Definite	MODERATE
	S2: Big GH_2		Extreme	Definite	VERY HIGH	Extreme	Definite	HIGH
	S0: Baseline	3 High	Moderate	More Likely	MODERATE	Moderate	More Likely	MODERATE
	S1: Small GH_2		Drastic	Definite	VERY HIGH	Drastic	Definite	MODERATE
	S2: Big GH_2		Extreme	Definite	VERY HIGH	Extreme	Definite	HIGH
	S0: Baseline	2 Medium	Moderate	More Likely	MODERATE	Moderate	More Likely	LOW
	S1: Small GH_2		Drastic	Definite	HIGH	Drastic	Definite	MODERATE
	S2: Big GH_2		Extreme	Definite	VERY HIGH	Extreme	Definite	MODERATE
	S0: Baseline	1 Low	Moderate	More Likely	MODERATE	Moderate	More Likely	LOW
	S1: Small GH_2		Drastic	Definite	HIGH	Drastic	Definite	MODERATE
	S2: Big GH_2		Extreme	Definite	VERY HIGH	Extreme	Definite	MODERATE

2.6 RECOMMENDATIONS FOR BEST-PRACTICE MANAGEMENT

2.6.1 General Guidelines

There is a wealth of information in South Africa dealing with best practice management guidelines for various types of land use and development that are the logical starting point for determining best practice guidelines for RE development. The most important guidelines are bioregional plans and the land use guidelines therein that relate to the various CBA map categories and the land use activities permissible in each map category. These guidelines are high-level guidelines that do not necessarily contain the level of detail necessary to fully mitigate impacts related to a specific development type (e.g. solar or wind energy facilities or powerlines) or impacts affecting specific taxa or ecosystems. The Namakwa District Biodiversity Sector Plan (Marsh et al. 2009) is the only bioregional plan with detailed land use guidelines covering the SEA regional area. In addition to covering terrestrial ecosystems, this document also has detailed management guidelines for aquatic ecosystems.

Further afield, related documents such as ecosystem guidelines and land use planning handbooks do contain more detailed information of best practices covering a variety of land use activities. These include:

- Ecosystem guidelines for the savanna biome (SANBI 2021), Western Cape including fynbos and succulent karoo biomes (Fynbos Forum 2016, Pool-Stanvliet et al. 2017) and grassland biome (SANBI 2013). These guidelines documents cover both terrestrial and aquatic ecosystems in these biomes.

- There is no succulent or nama karoo-specific ecosystem guidelines other than what is contained in the Western Cape guidelines, however, Todd et al. (2009) and Wilderness Foundation (2018) cover rangeland management best practice. Whilst these deal with livestock farming and veld management and are not directly applicable to renewable energy, as discussed below, these guidelines are directly relevant to the indirect impacts of renewable energy facilities.

- Wetland and aquatic ecosystem-specific guidelines are covered in the biome guideline document as well as some detailed wetland guideline documents (Edwards et al. 2018 and Lloyd et al. 2025). All these guidelines have a focus on more mesic ecosystems and the absence of a detailed guideline document dealing with aquatic ecosystems in the arid zone is perhaps a gap in the South African ecosystem guideline literature.

- Currently, there are no handbooks or guides tailored specifically to terrestrial ecosystems in the context of renewable energy development. Most impacts associated with renewable energy projects—such as linear infrastructure, powerlines, and land clearing—are comprehensively addressed in existing guidelines listed above. Nevertheless, because wind energy facilities uniquely affect flying animals, South Africa has developed several best practice guidelines focused on specific animal groups, namely birds (Jenkins et al. 2015; Simmons et al. 2020; Pfeiffer and Ralston-Paton 2018) and bats (MacEwan et al. 2020a; MacEwan et al. 2020b).

- The IUCN guidelines dealing with mitigation of environmental impact assessment associated with renewable energy projects (Bennun et al. 2021, Bennun *et al.* 2024, Jobson et al. 2024) provide valuable international perspectives and best practices that should be applied locally in relation to the development of RE in South Africa.

2.6.2 Development Specific Guidelines

Best practice guidelines can be grouped according to three categories of mitigation interventions: avoid impacts, reduce impacts (avoid degradation) and restore ecosystems.

2.6.2.1 Avoid sensitive habitat

All WP2 regional ecological studies highlight avoiding high sensitivity landscapes or habitats at the project planning phase as being the most important mitigation action. Renewable projects need to consider the wealth of spatial biodiversity data more rigorously at the project inception phase to avoid known sensitivities before the EIA stage.

The sensitivity analysis conducted here compliments CBA maps in that it considers information that is not necessarily used to inform CBA maps. They should therefore be used in conjunction to inform planning. There are, however, some important knowledge gaps relating to ecological corridors and migratory pathways that needs to be addressed to improve the sensitivity analysis.

Regional sensitivity mapping can be complimented at the site planning scale by detailed ecological mapping of proposed development sites before infrastructure planning has commences. This can significantly reduce project implementation time and expense by avoiding biodiversity constraints and high environmental risk area *a-priori*. Ecological mapping that “fine-scales” the region planning informants to site-level can identifying sensitive areas, no-go areas and ecological buffers or setbacks at a spatial resolution that is relevant to development planning thus providing a least-cost or environmental constraint temple that can be used by developers to design projects.

2.6.2.2 Minimise impacts on site and reduce degradation of the surrounding landscape

There is a wealth of best practice recommendations discussed in the documents listed above as well as the WP2 ecological report that detail technical standards for the design and operation of renewable energy facility aimed at reducing the impact of the activity both on site as well as impact propagation into the surrounding landscape. These include:

- The placement of sites in the landscape (i.e. avoid sensitive areas)
- General site design considerations to reduce attracting species to sites (e.g. minimise the creation of roosting and foraging habitat)
- General site design innovations to reduce physical footprint (e.g. raised PV installations to avoid/reduce clearing of PV sites).
- Reduce degrading surrounding landscape (e.g. reduce noise, eliminate fugitive light, control alien invasive species, etc.).
- Design specifications for individual infrastructure components to reduce or deter animal interaction (e.g. powerline visibility, pylon bird perches and insulators)
- Operational management to avoid operation during peak animal activity periods (e.g. diurnal cycles and seasonal migration).

Currently, best practice information is spread across multiple information sources. It is advisable that a comprehensive set of renewable energy guidelines be developed in South Africa to integrate available recommendations into a single document to support developers to minimise and mitigate their impacts. Having a single national standard will improve implementation success by containing key information in a single source and improve biodiversity outcomes as all operators would be working towards a common set of outcomes

2.6.2.3 Improve the ecological condition of ecosystems

Improving habitat quality and reducing ecological fragmentation of natural habitat surrounding developed areas is identified as one of the best mitigation measures available to help species buffer the loss of habitat and species mortality due to RE development. This includes the design and creation of corridors and core biodiversity areas (viz. protected areas), active restoration of degraded areas, and working with landowners to improve the ecological condition of their veld. Investing in improving habitat quality increases forage availability and quality for impacted species and improves ecological connectedness by maintaining high quality habitat for species movement.

Since livestock grazing is the most widespread land use activity that directly determines the health of ecosystems across almost the entire SEA area, working with this industry to improve livestock management for improved ecosystem health outcomes could be an effective mechanism to mitigate the ecosystem-level impacts of GH2.

For example, Todd et al. 2009 identify that removal of livestock from veld during drought periods is critical for maintaining rangeland condition through drought cycles. Current drought relief programs that enable livestock to remain on the veld through droughts via means of supplemental feeding is possibly the single most detrimental intervention farmers or the state can make. This intervention supports farmers in the short term to maintain herd size but in the medium to long term this leads to degradation of ecosystems in Namaqualand (Samuels et al. 2007, Todd et al. 2009, Letsoalo et al. 2025). As the impacts of GH2 will be at the whole ecosystem level, there is an opportunity for GH2 and agriculture to create a partnership to support local farmers through providing innovative solutions to circumvent the drought degradation trap. Incentives or mechanisms that support farmers to improve ecosystem condition within GH2 impact areas could also be viewed as an OECM and linked a wider biodiversity offset scheme through, for example, a biodiversity stewardship program.

2.7 RECOMMENDED STRATEGIC MANAGEMENT ACTIONS

2.7.1 Invest in the biodiversity knowledge base.

There is always a need for more foundation biodiversity distribution data to inform spatial planning, biodiversity management and development planning and management. The accuracy and detail of the sensitivity analyses is directly related to the quality of biodiversity data available. It is essential that biodiversity distribution data collected though EIAs and RE monitoring programs be captured and integrated with national datasets. Improved foundational datasets on the occurrence and distribution of species that is then used to improve sensitivity maps and CBA maps. This data can also be used to quantify ecological buffers around RE sites and during the operational phase of developments this data feeds into the adaptative management strategy of operations to identify, manage and mitigate environmental risks and impacts.

An urgent data collection / research question is the identification and mapping of migratory routes and roosts for cave dwelling bats and birds. This is a research priority. As part of the mitigation measures linked to GH2, it is recommended to initiate a dedicated region-wide biodiversity inventory and research program that can address this question as well as other knowledge gaps related to the impact and mitigation of GH2 in the region.

Monitoring of the impacts RE is essential. It is critical that observed impacts, particularly, mortality due to WEFs be related to species populations status and trends. Mortality rates must be used to inform population viability models for species of conservation concern for all regions in South Africa where WEFs operate to determine thresholds of potential concern (TCPs) for species. TCPs define species-, site- or region-specific trigger levels (e.g. population size, collision risk rates, displacement indices, breeding success, fatality thresholds) that mandate corrective/ adaptive management actions during construction and operations (Kellerman et al. 2026). More importantly, TCPs should be used to scientifically determine the maximum allowable WEF density or development cap per region so as not to reach the set TCPs. This should be conducted as a matter of urgency considering the rate and extent of WEF development in South Africa.

Monitoring data, especially mortality monitoring reports, from operational WEFs must be shared with DFFE and be made publicly available. Only if this data is made publicly available can it be rigorously used to improve mitigation measures at WEFs. The current lack of publicly available monitoring data has been identified as a key knowledge gap for birds and bats informing the sensitivity analyses.

All renewable energy facilities should have mandatory monitoring plans that are publicly available and independently audited. This should be a mandatory condition for GH2 development. The requirement for mandatory monitoring programs should be included in the set of best practice guidelines along with detailed technical specifications for the design and operation of the program. Also, all individual RE facility monitoring program should be integrated in the regional research program.

2.7.2 Mandatory GH2 best practice guidelines

Set mandatory GH2 minimum standards that detail best practice guidelines for planning, designing, constructing and operating renewable energy projects (Botha 2026). These should include innovative mitigation measures to reduce clearing of land for solar (e.g. pole-mounted PV), eliminating animal mortality during operation (e.g. blade and transmission line collisions and electrocutions), maintaining landscape connectivity (e.g. maximising linear infrastructure permeability to wildlife), reduce or eliminate propagation of impacts leading to degradation of surrounding (e.g. sound and light abatement, road crossings and hard surface flood water management). Guidelines must explicitly include measures for sustainable water management. Namaqualand is an arid area, however, there is still a great diversity and abundance of aquatic ecosystems that are generally all sensitive ecosystems with high ecological importance.

The GH2 best practice guidelines should cover all aspects best practice discussed in Section 2.6, and ideally should become the **mandatory minimum standard operation procedures (SOP)** necessary for any RE project to me to qualify for an operation licence and grid access in South Africa.

2.7.3 Invest in refining spatial biodiversity planning

Spatial biodiversity planning is clearly important for supporting economic development in the region by helping development identify and avoid areas of highest sensitivity in the landscape. Investing in improving the quality of the input data (see above) will only improve the confidence with which this information can be used. Several areas where spatial planning can improve include:

Design an **ecological corridor network** for the region or “develop the detailed spatial framework for Vision 2040”. This regional ecological corridor network is the basic building blocks of Vision 2040 and the biodiversity economy. This network connects all core biodiversity conservation landscapes in the Namakwa Region with one another and with those neighbouring regions such as the Knersvlakte (south), SKA (east) and Sperrgebied (north). It is imperative that the spatial framework for Vision 2040, mega-living landscapes and the landscape ecological corridor network be laid down before GH2 is implemented to avoid corridors being cut or diverted by poorly located development. This biodiversity spatial framework should be used as a baseline spatial layer informing where GH2 infrastructure can be in the landscape to aligned with the biodiversity economy aspirations of the region.

A key element currently missing from the regional ecological corridor network are the spatial requirements for migratory bats and birds, specifically migratory routes (fly ways), roosts and breeding areas. These are poorly known and are not well considered in current conservation plans. This is an urgent research priority.

The biodiversity spatial framework indicates core biodiversity protection landscapes in the region and the ecological corridor network connecting these areas. It therefore becomes an important tool informing the protected area expansion strategy and thus provides the spatial blueprint for biodiversity offset receiving areas (see Botha 2026).

Other recommended spatial planning activities include

Conduct a national scale RE SEA to determine no-go or set aside areas for RE development where RE projects cannot be proposed. A key informant will be using observed mortality rates and population viability models to determine limits on RE development to prevent loss of species populations.

Embed bat and bird sensitivity mapping information into planning tools (e.g. EMFs, SDFs, IDPs), identify no-go zones for critical habitats that can be incorporated into CBA maps, map evidence-based buffers for critical habitats, and identify and map least cost linear-infrastructure corridors to avoid high-risk avian areas and maintain landscape connectivity.

2.7.4 Plan for the biodiversity economy

Significant environmental impact and conflict with the biodiversity economy sector can be efficiently avoided through informed spatial planning of GH2 rollout.

The Namakwa Region is part of the Succulent Karoo Biome, a global biodiversity hotspot. Therefore, there are extensive and widespread biodiversity sensitivities throughout the region that will influence where and how development should be planning in the region. The spatial analysis demonstrates that at least 70% of the landscape is considered medium to very high biodiversity sensitivity.

As a result of the regions global biodiversity hotspot status there is considerable effort going into growing the protected area network and developing the biodiversity economy. This affects as much as 70% of the region. Biodiversity conservation is an important land use and significant force for rural economic development. Therefore, new developments entering this landscape need to be sensitive to this reality. Biodiversity conservation is like mining in that it is inextricably linked to where resources are located in the landscape. These are fixed meaning that for the most part there is low spatial flexibility as to where these land uses can develop. In contrast, agriculture, human settlement and infrastructure and renewable energy are not directly linked to fixed natural resources and therefore there is a greater measure of spatial flexibility as to where these can develop in the landscape.

It is important that GH2 does not compete with the conservation sector for high biodiversity value land. Therefore, the key policy recommendation for the development of GH2 in the region is to be cognisant of the regions exceptional biodiversity, the spatial blueprint for the development of the biodiversity economy (i.e., the biodiversity spatial framework, protected areas expansion strategy, Vision 2040 and mega-living landscapes) and the spatial constrains on this blueprint imposed by the intricacies of the regions exceptional biodiversity. The sensitivity analysis has shown that at least a third of the region is considered in the lower sensitivity category leaving ample room to accommodate the stated land requirements of the GH2. It is imperative that GH2 development demonstrate spatial flexibility in where it develops to minimise biodiversity impact but more important to not to compromise the economic potential of the biodiversity economy in the region.

2.7.5 Visual impacts and protecting sense of place

It is important for the GH2 development to be aware of the physical landscape in which it is operating. Landscape "wilderness" aesthetic or sense of place is an important economic resource. The naturalness of the Namaqualand landscape and the distinct visual aesthetic is a key resource supporting the tourism industry and hence the biodiversity economy. It is important to acknowledge this and strive toward protecting this resource within the GH2 development ambitions. Where possible the GH2 should align and support that biodiversity economy ambitions, which are spatially less flexible, rather than conflicting with biodiversity economy options. To this end biodiversity sensitivity and visual aesthetic are linked and hence the recommendation for considering visual impacts.

Protected areas and the biodiversity economy in the region will continue to grow to cover at least 30% of the region by 2030. Tourism is a big part of this economic growth. Sense of place and landscape visual character are critical components of the nature experience. Renewable energy can be very destructive to visual resources. In addition to avoiding biodiversity sensitivities, it is very important to consider the visual impacts of development. Whilst visual and biodiversity impacts are not correlated, within the context of protected area development and the biodiversity economy where nature in natural landscapes is the primary economic resource, they do have an important relationship from an economic perspective.

2.7.6 Proactive mitigation and biodiversity offsets

The extent to which cumulative, indirect, or induced impacts from the entire GH2 fleet and SEZ can be attributed to any individual project remains uncertain. This complexity makes it challenging to assign offset liability and supports the recommendation that SEZ proponents should proactively address impacts on behalf of future tenants. By investing in forward-looking offset schemes, the SEZ could facilitate smoother implementation, minimize land use conflicts, and effectively manage risks to important biodiversity sites and ecological corridors (Botha 2026). Adopting this proactive strategy toward offsets would provide greater transparency regarding offset outcomes and associated costs, thereby supporting more effective budgeting, planning, and regulatory compliance.

The offset strategy should support the biodiversity economy by using GH2 biodiversity offsets, where appropriate, to build the regions protected area network (Botha 2026).

Linked with a proactive offset strategy should be a proactive mitigation strategy. GH2 should consider establishing a mitigation fund linked to GH2 projects to fund:

1. Retro fitment of installed infrastructure such as powerlines, fences and roads to meet biodiversity and ecosystem design standards for wildlife permeability and mortality reduction, and freshwater quality.

2. Ecosystem restoration projects identified as part of a broader impacted mitigation strategy aimed at improving the general ecological condition of landscapes impacted by RE (see above).

2.7.7 Integrated GH2 mitigation and biodiversity offset strategy and implementation plan

Planning for the biodiversity economy, investing in the scientific knowledgebase, spatial biodiversity planning, protecting the sense of place, and implementation of proactive mitigation strategies and biodiversity offsets should all be developed and implemented through a singular integrated regional-scale GH2 mitigation and biodiversity offset strategy and implementation plan rather than on a project-by-project basis. This implementation plan should include:

- An implementation plan and spatial framework that supports the biodiversity conservation vision for the region. The plan should give expression to the regional protected area network (i.e. blue print for the living landscape) and be aligned with and develop upon the provincial and national protected area expansion strategy and Vision 2040.

- Provides a spatial plan that identifies potential recipients of biodiversity offsets and mitigation (i.e. ecosystem restoration areas) linked to GH2 development.

- Identifies and mandates the key role players (state, scientific community, civil society and NGO) necessary to develop and implement the plan.

- Provides a clear funding model to support the purchase and management of conservation land linked to the quantum of GH2 investment. Funding should also cover implementation of mitigation measures and funding the development of the biodiversity economy linked to this investment.

- Recognising that the protected area estate is the cornerstone of the biodiversity economy, identify practical pathways for economic beneficiation of the conservation estate. Included here is identifying the beneficiaries of the biodiversity economy components specifically linked to the GH2 investment.

- Sets clear time-bound area and funding targets to be achieved within 5-, 10-and 15-year implementation horizons that are aligned with the rate and extent of GH2 development.

- Provides for regular (3–5-year intervals) review of the implementation strategy.

- Provides for independent oversight and review of the implementation plan and outcomes.

2.7.8 Build a community of practice

Capacity and coordination: DFFE should establish a national biodiversity and renewable energy technical forum to foster scientific research and communication between stakeholders (scientists, regulator, conservation, operators, developers and landowners). In the South African experience, creating a community of practice that facilitates and promotes the interaction of role players and sharing/communicating of information is an excellent strategy for unlocking the skills and benefits of the regions limited and dispersed scientific and research resources. Examples such as the Biodiversity Planning Forum, Fynbos Forum, Arid Zone Ecology Forum, SKEP, Thicket Forum, etc. are all testament to how investing in communication can bring science, policy and implementation together to unlock tangible on the ground outcomes for biodiversity and the environment.

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2.9 Appendix 1 Summary of Datasets

Table 2-14: Summary of projects with biodiversity prioritisation datasets of relevance to the Namakwa Region.

No.	Data Name	Source	Reference	Notes
1	Namakwa District Biodiversity Sector Plan 2009	http://bgis.sanbi.org/Projects/Detail/52	Marsh *et al.*, 2009	
2	Richtersveld Municipality Biodiversity Assessment 2008	not available online	Berliner & Desmet 2008	Incorporated into NDM BSP
3	Northern Cape Critical Biodiversity Areas 2016	http://bgis.sanbi.org/Projects/Detail/203	Holness & Oosthuysen 2016	Superseded by 2024 version
	Northern Cape Critical Biodiversity Areas 2025	not available online	Oosthuysen & Geldenhuys 2025	
4	National Protected Area Expansion Strategy, NPAES 2010	http://bgis.sanbi.org/Projects/Detail/144	reference?	Superseded by NPAES 2017
5	National Protected Area Expansion Strategy, NPAES 2017	not available online	DEA 2017	
6	Northern Cape Protected Area Expansion Strategies, NC PAES	not available online	no reference	Included in NPAES 2017
7	DENC Protected Area Development Focus Areas	not available online	Desmet & Helme 2017	
8	Namakwa District Ecosystem Based Adaptation Priority Mapping (2015)	http://www.conservation.org/publications/Documents/CI-CASCADE-Namakwa-Vulnerability-Assessment. pdf	Bourne *et al.* 2015	
9	Richtersveld Important Biodiversity Areas, Pieter van Wyk, 2018	This project	This project	
10	SANBI Threated Species Program - Species point localities for threatened & rare species, 2017	not available online	Data obtained directly from SANBI in 2017	
11	Leslie Hill Succulent Karoo Trust Priorities	not available online	Desmet 2006	
12	Bushmanland Conservation Initiative	not available online		
13	WP2 Bird Assessment			
14	Key Biodiversity Areas (KBAs)			
15	Important Bird Areas (IBAs)			

2.10 Appendix 2 Biodiversity Sensitivity Analysis Technical Notes.

Biodiversity Plan Sensitivity

The biodiversity spatial planning inputs (Table 2-16) were combined into a 4-class high-low category map as follows:

1. For SANBI threatened species, re-classifying the mapped categories in the input datasets into CBA Map equivalent categories (Table 2-16).

2. Re-classify the CBA map codes into a binary code (Table 2-15).

3. Sum the binary codes for all inputs. The use here of a binary code allows for raster grids to be added using ArcGIS Map Calculator whilst retaining the underlying CBA/ESA status classification of individual input datasets.

4. Following a maximum of inputs principle, re-classify the summed binary code into a combined CBA map category. For example, after adding the binary CBA code for all input grids together, a final value of 1120 means that the site was categorised as a PA in one of the inputs datasets (1 x 1000), as a CBA1 in one dataset (1 x 100), as a CBA2 in two datasets and not identified as an ESA in any of the input datasets.

5. Re-classify the CBA map categories into 4-class high-low categories (Table 2-15).

Table 2-15: Re-classification look-up values used in the integration analysis.

Original Input Classification	Re-Classification Binary Code	4-Class Value	Class Name
Other natural area, no value	0	1	Low
ESA	1	2	Medium
CBA2	10	3	High
CBA1	100	4	Very High
PA	1000	4	Very High

Table 2-16: Summary of individual input datasets integrated in this analysis and their relevant re-classification look-up values.

No.	Name	File Name	Field Name	Re-Classification Values
1	Namakwa District Biodiversity Sector Plan 2009	NDM_biodiversity_corridor.shp NDM_expert_critical_terrestrial.shp NDM_expert_important_terrestrial.shp NDM_kloofs.shp NDM_slopes.shp NDM_vegetation_CBA.shp	Various labelled ESA_* or CBA_*	T1 or A1 = 100 T2 or A2 = 10 EAS_T = 1
2	Northern Cape Critical Biodiversity Areas 2024	Northern_Cape_CBA_Map.shp	CBA_CAT	Critical Biodiversity Area One = 100 Critical Biodiversity Area Two = 10 Ecological Support Area = 1 Other Natural Areas = 1 Protected Area = 1000
5	SANBI Threatened and Rare Species Point Localities, 2017[1]	Allthrspp_nc_feb2017 and NC_TOCC_feb2017	VALUE	CR, EN & Cr Rare Sp. = 100 VU & Rare = 10

Notes:
1: SANBI TSP data – selected only species with locality accuracy of 5000 or less.; Buffered points by 250m

Protected Area Expansion Sensitivity

The protected area expansion and development inputs datasets were combined into a 4-class high-low category map as follows:

1 All areas earmarked by each input in Table 2-8 were classified as 1, i.e. area earmarked by a protected area expansion or development plan.

2 The six input layers were then added together resulting in values ranging from 0 (not earmarked by any input) through to a maximum of 6 (area earmarked by all six inputs).

3 This combined layer was then reclassified into a 4-class high-low classification scale as follows (Figure 2-21):

Input Value (Number of overlapping plans)	4-Class Value	Class Name	Interpretation
0	1	Low	No plan has earmarked this area for PA expansion of development
1	2	Medium	
2	3	High	
>=3	4	Very high	3 or more plans have earmarked this area for PA expansion or development

2.11 Appendix 3 Succulent Karoo Expert Areas Dataset

Expert mapped important areas for biodiversity in the Succulent Karoo (Figure 2-18) is an important biodiversity database that captures knowledge on the distribution of biodiversity from relevant plant experts. In the absence of detailed species distribution datasets or models, the expert mapped areas have historically been a key informant of biodiversity plans and protected areas expansion strategies. This map was first developed by Desmet (2006) in response to the lack of species-level spatial information available for conservation planning and was updated in 2012, 2019 and again as part of this project with data for the Richtersveld from Pieter van Wyk as part of WP1 (Figure 2-18).

Expert mapped areas are, in the opinion of the individual expert interviewed, important areas for the representation and conservation of biodiversity in the Succulent Karoo based on the presence of endemic/rare/threatened plant species and/or unique/rare habitats or species assemblages. The purpose of the dataset is to distil the wealth of expert field-based knowledge on the patterns and distribution of biodiversity in the Succulent Karoo into a spatial dataset that can inform conservation planning, specifically the activities of the WWF-managed Leslie Hill Succulent Trust (LHSKT). In total 23 plant biodiversity experts have contributed to the Succulent Karoo Expert Areas Database since inception with a total of 174 unique areas being mapped covering 1 721 949ha or 17% of the Succulent Karoo biome.

Table 2-17: The list of plant biodiversity experts who have contributed to the Succulent Karoo expert mapped areas database.

Expert Name	Year				Total
	2007	2012	2019	2025	
Adam Harrower	10	4			14
Andrew Young		17			17
Chris Rodgerson	10	10			20
Dee Snijman, John Manning & Peter Goldblatt	11				11
Derek Tribble		18			18
Desmet & Helme		16	1		17
Ernst van Jaarsveld	8				8
Florent Grenier			1		1
Graham Williamson	21				21
Helga van der Merwe & Enrico Oosthuysen			1		1
Jan Vlok	15	3			18
John Lavranos	10				10
Matthew Opel		4			4
Norbert Kleinmichel	10				10
Peter Bruyns	18	2			20
Philip Desmet	70				70
Pieter van Wyk			1	47	48
Steven Hammer	22	13			35
Terry Smale	12				12
Tom Jacobs	21				21
Grand Total	**238**	**87**	**3**	**47**	**376**