CHAPTER 3

Supplementary Material: Specialist Report

(B) Vegetation and flora report

BOEGOEBAAI STRATEGIC ENVIRONMENTAL ASSESSMENT

FLORA OBSERVATIONS OF THE BOEGOEBAAI PORT DEVELOPMENT SITE AND SURROUNDING AREAS, RICHTERSVELD MUNICIPALITY, NORTHERN CAPE, SOUTH AFRICA

(B) VEGETATION AND FLORA REPORT

Report compiled by:

Pieter C.V. Van Wyk

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INTRODUCTION

The Richtersveld region already contained 336 known endemic plant taxa by 1999 (Cowling et al. 1999), however continuous new discoveries proofs that this figure is exceeded by far (Van Wyk et al. 2024). It is acknowledged as one of the richest desert floras of the planet (Cowling et al. 1998) and forms part of a 'biodiversity hotspot' defined to set conservation priorities (Meyers et al. 2000).

The introduction of the Biome concept, based largely on a classification of growth forms and major climatic determinants has led to the description of South Africa's 7 biomes. Of these biomes Fynbos, Succulent Karoo and Nama Karoo Biomes occupy southern Africa's southwest winter and summer rain fall region (Rutherford & Westfall 1986) and a later introduced biome, the Desert Biome (Rutherford & Westfall 1994). A map introducing the seven biomes of South Africa, namely: Savanna, Thicket, Grassland, Forest, Fynbos, Nama Karoo, Succulent Karoo, and Desert were introduced later (Rutherford & Westfall 1994; Low & Rebelo 1996; Mucina and Rutherford 2006). The Richtersveld is unique in that it is situated within four of these biomes, namely the Succulent Karoo Biome, Desert Biome, Fynbos Biome and Nama Karoo biome (Jüergens 1991), and this is possibly the main reason for the unusual high biodiversity found within the area, even though the aridity and harsh climate. Of these biomes the Fynbos and Succulent Karoo biomes have recognition as two of Earth's biologically richest and most endangered terrestrial Eco regions (Mittermeier et al. 1999). The Boegoebaai Port project falls within the Succulent Karoo Biome.

Looking past the biome level and more towards a human introduced border, such as a municipal area, the Richtersveld Municipal area has a figure of endemic flora, total number of flora and endangered flora as well as vegetation units, exceeding by far, any municipal area in the Northern Cape Province (Van Wyk et. al. in prep.). Even though the Richtersveld Municipal area has the lowest annual average rainfall of any municipal area in the province, the biodiversity is unlikely elsewhere and this is greatly contributed towards the complexity of the region's geology, topography, climate, and long climate as well as geological stability. Keeping this in mind, should there have been a scale for rating districts and municipal areas according to their importance to biodiversity, the Namakwa district and the Richtersveld Municipal Area (see Image 1) would have rated as the most important in the Northern Cape Province.

Of all the species and ecosystems found within the Richtersveld Municipal Area, the Alexander Bay Lichen Fields is by far thee-most extraordinary ecosystem, not only in the region but on earth. The Alexander Bay Lichen fields falls under the Namib Lichen Fields and is a South African Heritage Site It is also one of the most threatened habitats in the world! The lichen fields are the largest and richest of its kind in the world, and they are considered an ecological wonder by scientist across the world, due to their density and species richness. Due to its uniqueness the Alexander Bay Lichen Fields, they have received a conservation aim of being conserved 100% (Mucina and Rutherford 2006). Not well documented but of equal importance and uniqueness are the lichen fields found on the Boegoeberg South and Boegoeberg North hills.

Over the past years rare and new endemics species are still being discovered in the Richtersveld whilst at the same time species are disappearing (Van Wyk et al. 2024). More than 90 years of mining, bad agriculture practices and land use transformation has let to what scientist referred to as the perfect storm (Jurgens et al. 2025). Mass_desertification are causing extinction, this desertification are anthropogenic. One can clearly see how species are becoming more endangered by looking at the species listed for the Richtersveld Municipal area on the SANBI Red List (see table 4). It is this also a fact that the Richtersveld Municipal area is the most threatened municipal area in regard to biodiversity of any municipal area in the Northern Cape Province. The level of threats can also be seen in the recent publication of species richness of the Richtersveld National Park, which proved that the Richtersveld National Park has the highest number of red listed species, of any of South Africa's National Parks.

As a result of the threats, in 2015 the South African National Biodiversity Institute (SAMBI) joined forces together with South African National Parks (SANParks) to reassess the endemic flora of the Richtersveld. A first up-listing of plant taxa from this region, where completed in 2015, which was published on the South African Red List of Endangered species (Raimondo et al. 2015) (see image 3). A second phase of updating the red list statuses of flora from the region commenced in 2022 and several species were up listed on the red list in 2023 (Raimondo et al. 2023), mostly due to new threats mining posed along the Orange River. The need for a third up-listing of species, due to threats becoming more, was commence in 2024, as a result of the Boegoebaai Port related developments, and the impacts this development will have on species (Raimondo et al. in prep. 2025).

This report is a local-scale, spatially focused SEA report identifying sensitivities within and surrounding the proposed port and affiliated developments, including the SEZ development area covering ~33 500 ha ("Boegoebaai Port and SEZ SEA") as well as the surrounding area, the Richtersveld Municipal Area and sections of the Nama Koi Municipal area (Image 1 & 2).

Furthermore, this report was conducted using expert on-site, ground-truthing to produce high resolution spatial data, which are overlapped with existing database of plant species occurrence within the study area. From this data sensitive and non-sensitive areas could be pointed out. From the data collected for this report, unique habitat was also documented and mapped, of the most unique habitats, includes, lichen fields and plant communities associated with brant's whistling rats and heuweltjies. This report also explored the species richness of the Richtersveld Municipal area and includes a graph showing the number of threatened plant species as listed on the SANBI red list (Table 4, towards the end of the document) annually, and how the number of species becoming threatened are growing.

STUDY AREA

The Study area includes the Richtersveld Municipal area and a small section of Nama Koi Municipal areas (Image 1 & 2). Both Municipal areas falls within a region known as the Richtersveld and Northern Namaqualand. The border of the study area in the east is the tar road between Steinkopf and Vioolsdrif, in the north the Orange River from Vioolsdrif towards Alexander Bay, in the west the shoreline between Port Nolloth and Alexander Bay and the southern border of the study area for this report is the tar road between Port Nolloth and Steinkopf. The core area of this report is the proposed port and SEZ development area covering 33 500ha known as the "Boegoebaai Port and SEZ SEA" (*Image 2*). The area is situated within the Richtersveld Municipality area, in the north-western corner of South Africa (*Image 1*), close to the small mining town of Alexander Bay and partly falls within South Africa's Succulent Karoo and Desert Biomes.

Image 1: Districts and Municipalities of the Northern Cape Province.

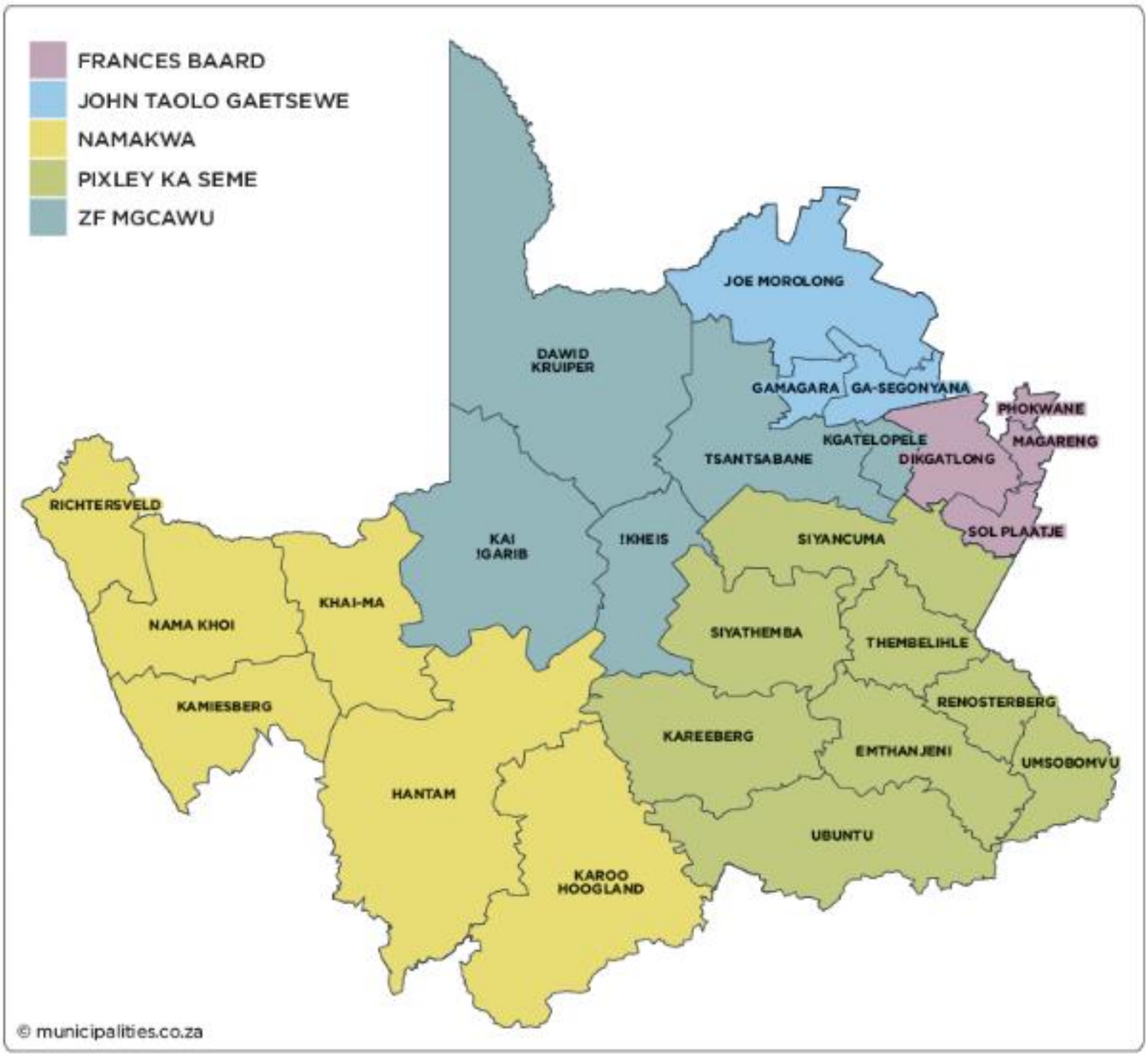


Image 2: Close up map of the 33 500ha study area (Image: © Google Earth 2023).

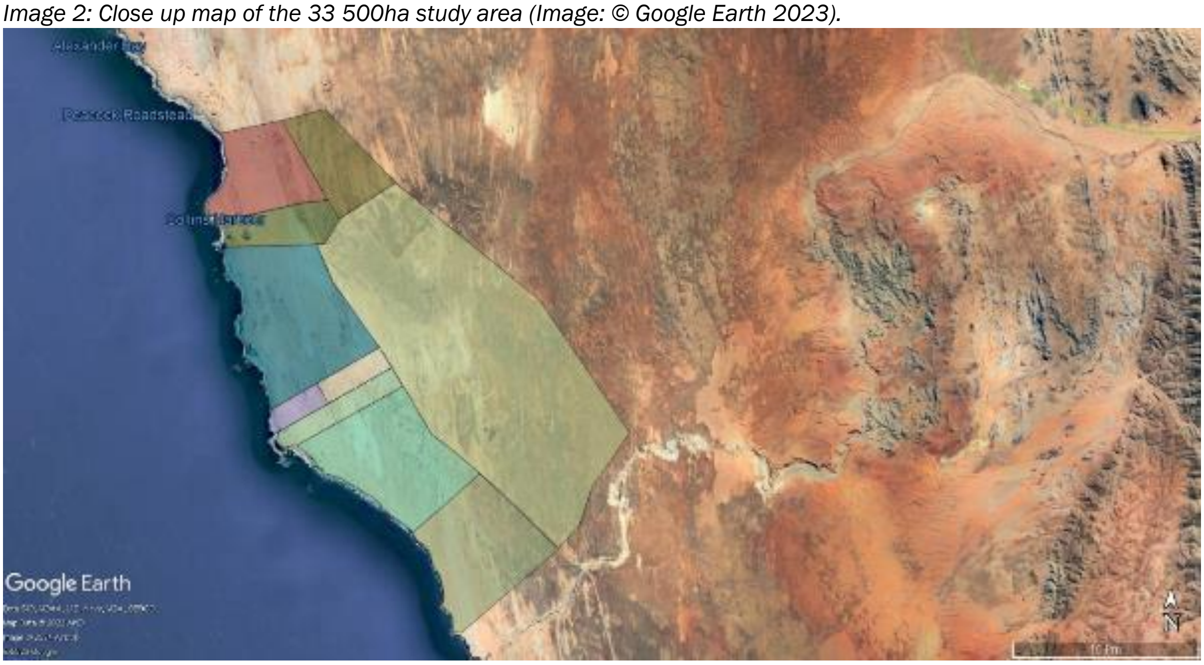
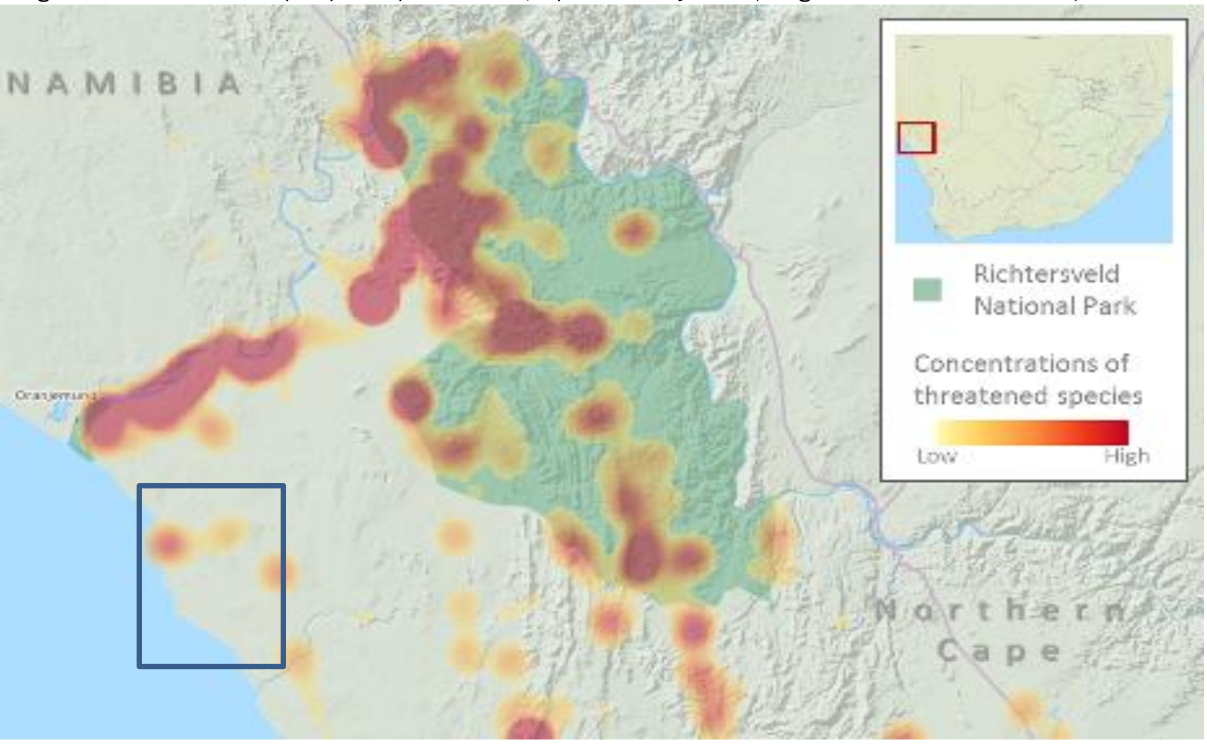


Image 3: SANBI Red List map of plant species 2015, square = study area. (Image: © SANBI Red List 2015)



METHODS AND MATERIAL

Before doing site visits, high resolution satellite images and the vegetation map of South Africa were studied. From this desktop activity, strategic points were chosen as samples sites within all land types of the core study area and some sampling surrounding this area. Hereafter, site visits were conducted. Whilst visiting strategic sites, any area which visually seemed unusual regarding plant communities, whilst on the site, were also visited.

When data was collected two methods of sampling were done, one was point sampling of individual species, uploaded onto iNaturalist or for which herbarium vouchers were collected and two, collective data collection within a 10m x 10m ($100m^2$) plot.

<u>Sampling method one</u>: data was gathered by taking photos of species, together with GPS and uploading the photos onto iNaturalist as well as adding the photos to a private photo herbarium for the Richtersveld bio region belonging to the author of this report). Encase species could not be identified, using photos, herbarium voucher collections were made, but only outside the restricted mining area, as no permission was obtained to collect herbarium vouchers within the mining area. When voucher specimens were collected, the following information was also collected using a standard Herbarium Collection Form: GPS coordinates, Altitude, Vegetation Type, Substrate, Moisture regime, Soil type, Lithology, Exposure, Aspect, Slope, Biotic effect, and Plant Features which included: growth form, height, flowering, or fruiting. Herbarium voucher of plants were pressed, frozen at -15°c after which it was dried at 65°c. Also included encase of species of special concern, counts of the species were done within a radius of 50m of the individual GPS point.

<u>Sampling method two:</u> data was gathered in a $100m^2$ square plot of 10m x 10m, this was done several times within all land types, as well within various altitudes of the study site. Within each plot the following information was gathered: GPS, altitude, soil type, lithology, all floral taxa including higher plant taxa as well as lower, estimation crown coverage in percentage per species, overall percentage of vegetation cover, and counts of species of special concern. This methodology was used to compare the various plant communities within the land types.

Plant species identifications was done by comparing herbarium material at Compton, Bolus, Stellenbosch, and SANBI, Pretoria Herbariums, or contacting taxonomic specialist where applicable. A Nikon SMZ800 microscope was used to examine finer detail.

Herbarium vouchers of Lichens and Mosses was also made from outside the mining area. When voucher specimens were collected, the following information was also collected using a standard Herbarium Collection Form: GPS coordinates, Altitude, Vegetation Type, Substrate, Moisture regime, Soil type, Lithology, Exposure, Aspect, Slope, Biotic effect, and Plant Features which included: growth form, height, fruiting and photographs for colour references of species. When sampling the lichen, mosses, and liverworts they were collected within 100m² quadrants. Within these quadrants all lichens & bryophytes seen were sampled, those on rock were chiselled from the rock with a piece of substrate still attached, those on plant material were sampled with the plant material be it branch or leaf and those on soil were gently removed from the soil and wrapped in acid free toilet paper (to prevent crumbling of the thallus and the soil which keeps the lichen in one piece). These were then placed in plastic containers to prevent damage to the voucher specimens. Processing of the voucher specimens were done at a later stage, for this they were carefully removed and sorted. Soil lichen was treated by brushing 20% cold glue mixed with 80% water on the lower part to prevent them from crumbling. The fruticose specimens were dipped in water and gently pressed to enable better mounting and storing of specimens.

Lichen species identification was done by observing them under a dissecting microscope (10x magnification eyepiece and 0.65 to 4.5x magnification, thus 6.5 to 45 x magnifications). The lichens are then separated into the same species within a sampling area and each species is then further identified by means of spot tests using iodine, a 10% solution of potassium hydroxide, and bleach. During a spot test a certain part of the lichen is tested, for example, the medulla or apothecia and its reaction to a certain chemical. Colour change or lack of colour change is noted and compared to keys for lichen identification. Lichens of the Namib Desert (Wirth, 2010) was used for identification of the voucher specimens. Some lichen specimens were given to lichenologist to examine and identify.

The conservation status was obtained by searching the SANBI Red List for each species (http://redlist.sanbi.org/). Photos were also taken of different habitats, and notes made on any unique forms of fauna, soil, micro habitats ext., which contributes to any unique plant species or communities' existence.

RESULTS

Species

In total 69 10m x 10m plots were completed for this study (Image 26) and over 8 000 individual points of species were collected.
In total 331 higher plant taxa were recorded for the 33 500ha "Boegoebaai Port and SEZ SEA" planned development site (Table 1 & see Image: 2 for study area) and in total over 3 000 higher plant taxa and over 300 lower plant taxa for the Richtersveld Municipal area (Van Wyk personal observation). Lower plant taxa recorded were an astonish amount of 91 taxa, even though this was not the primary focus of this study. Most of the lower taxa were lichens, highlighting the richness and importance of the locality as a 'centre of diversity' for lichens, likely of global importance (Table 2). In combination the total floral taxa, including Spermatophyta, Bryophyta, Fungi and Lichens totalled at an astonishing 422 taxa for the 33 500ha "Boegoebaai Port and SEZ SEA" development area. In total 36 red listed taxa were recorded and in additional 15 species which will become of conservation concern should this development footprint not be shifted to west of the tar road between Alexander Bay and Port Nolloth, were recorded, this in total 51 plant species of conservation concern were recorded (Table 3). Of the red listed plant species within the study site, 4 species are already listed as endangered, and 5 species are listed as critically endangered.

Image 4: ±95% lichen cover of all strata on the south-western slopes of Boegoeberg South.

Vegetation

This report does not include land types, but rather a brief description of some plant communities. From the various sampling sites of species in plots, it became clear that altitude as well as broader land types plays a much less important role in the distribution of species within the study site, it is rather soil chemistry and exposure to wind and fog that plays the more important roles. It became clear that looking at satellite images does not help much in defining the vegetation units of the study area. This said, looking at the vegetation types as described in South Africa for the study site, in the field made no sense. According to the vegetation types of South Africa, only 4 vegetation units are found within the core study area, however there are at least 8 main plant communities within the study site, which can be considered as "vegetation types". These communities are however interwoven in a complex matter making mapping a mess. Furthermore, during the research for this study, the difference in vegetation according to altitude was also explored, in the sense of highlands areas vs lowland areas, and again, this made no sense as over and over plant communities were found in the lowland and highland areas of the study site, depending on the soil conditions rather.

Here are a brief description and names of the various plant communities recorded within the study site:

Alexkor Moon Landscape

This vegetation exists out of two perennial species, a species of *Caroxylon* (ganna) and *Osteospermum polycephalum* (janneper se kaneel), which are extremely sparsely distributed within vast sections of the mining area south Alexander Bay. Where these species are found in combination, the previous plant communities have been 100% destroyed by the mines, this waist land has zero chance of recovery and in comprises most of the yellow areas marked in Image 22 of the report. Plots including this plant community: AL11; AL29-AL32.

Boegoeberg Strandveld

This vegetation is poor in species generally, with one to two species of special concern. It comprises of a combination of vegetation found on bright white dunes, which are dominated by *Cladoraphis cyperoides* (steekbiessiegras) and *Tetraena clavata.* The poor species cover within this vegetation is likely due to exstreme sand blasting caused by unrehabilitated mine quarries and comprises of 50% of the area west of the tar road between Port Nolloth and Alexander Bay. Plots including this community: AL8-9; AL14-16; AL18; AL27-28; AL66.

Boegoeberg Dwarf Succulent Shrubland

All quarzitic rocky outcrops within the study area shares the same plant community structure. These communities are uniquely different to the plains east of Alexander Bay and any rocky areas elsewhere in the Richtersveld. This is also the smallest plant communities even though the most species rich. Several narrow endemics and two localized endemics are found on these. The most dominant features are the presence of *Antimima perforata, Conophytum saxetanum* and various dwarf species of *Crassula* such as *C. plegmatoides*. Plots including this plant community: AL1-7 and AL67-68.

Silty Plains Scorpiontail Succulent Shrubland

This is the most widespread plant community within the study area. Even though much poorer than the yellow and red dunes as well as rocky areas, this unit still host several unique species. The most dominant species in this unit is *Mesembryanthemum pseudoschlichtianum* (skerpioenangel), *Lampranthus otzenianus, Amphibolia succulenta* and *Mesembryanthemum dinteri*. Plots including this plant community: AL13; AL21-23; AL37-38; AL44-48; AL53-58; AL60-63.

Rooi T'kooi Succulent Shrubland

This plant community is found on yellow dune sand throughout the study site and predominantly dominated by *Stoeberia utiles* (rooi t'kooi). It host the highest species numbers and tallest vegetation within the coastal plains of the region. Plots including this plant community: AL19-20; AL24; AL35-36; AL39-43; AL49-52; AL59; AL64-65.

Vaal T'kooi Dwarf Succulent Shrubland

This plant community consist out of dwarf succulents, of which *Stoeberia beetzii* (vaal t'kooi) is most dominant and *Drosanthemum luederitzii.* This combination of plant species are found on pale loamy soils, sometimes with calcrete and quartz pebbles and are extremely spotty, sometimes appearing as if heuweltjies, however these are likely remnants of old brant's whistling rats nests. Plots including this plant community: AL10; AL25-26.

Salt Marsh

Plant community which grows in high salinity and damp soil, with three springs which include sedges such as *Juncus acutus* subsp. *leopoldii*, and salt pans with *Limonium dyeri* and *Frankenia pomonea*. Plots including this plant community: AL12.

Namib Lichen Fields

This included areas where there are high presence of *Caloplaca* and *Xanthoparmelia* species on the soil and small stones which are typically associated with the same type of habitats and species within the Namib Desert. Plots including this plant communities: AL17; AL23.

Image 5: Unique combination of succulents on Boegoeberg North.

Image 6: Unique lower plant taxa, lichens and moss species on Boegoeberg North.

Image 7: Boegoeberg endemic, undescribed species of Antimima.

Image 8: possible new species of soil orchid from Boegoeberg belonging to the genus Holothrix.

Most significant are the Boegoeberg North and Boegoeberg South plant communities, which in combination of succulents and lichen cover should be considered of global uniqueness (*see Images 4-8*). Furthermore, the several localities of Namib desert lichen fields, which has a very limited distribution in South Africa, are also unique of the core study area (*see Images 9-11*). Other unique vegetation containing high density of lichen cover on shrubs, was also observed, some of these sites might potentially hold the highest % of lichen cover biomass for any vegetation units on the coast of South Africa (*see Images 12-13*).

A unique discovery was also made during this study. Thousands of active Brant's Whistling Rats (*Parotomys brantsii*) nests which are active where discovered. The positive reaction of plants to the activities of these rodents made it clear that they are important ecosystem engineers, which has been transforming the plant community structure, possibly for hundreds if not thousands of years. Each den may have several rats, and there are thousands of dens within a large section of the planned Boegoeberg development area (*see Images 14-16*).

Another unique vegetation feature within the footprint area which has a fauna component attached to it, is large sections of heuweltjies, where Harvester Termites (*Hederotermis*) are ecosystem engineers, creating special nutrient rich loamy soils, which create habitats for certain plant species. A paper was published in 2024 about the importance of heuweltjies and evidence provided by the Stellenbosch University that some of these termite colonies has been occupied for tenth of thousands of years and are carbon zincs of global importance (*see Images 17-19*).

The study area includes a newly discovered, species of *Pelargonium*, which made headlines in media, 2023 (*see Image 20-21*). There might still be several unknown species, especially geophytes within this study site.

Image 9: Caloplaca elegantissima

Image 10: Xanthoparmelia walteri

Image 11: Stony flats at Duikerkop, containing several Namib Desert Lichen species.

Image 12: Strandveld vegetation covered with over 60% Xanthodactylon species on woody shrubs.

Image 13: Xanthodactylon turbinatum densely covering wood, and a green Ramalina fimbriata.

Image 14: Google Earth Image of Brant's whistling rats nest/dens north of Duikerkop, showing unique patterns of vegetation associated with these rats.

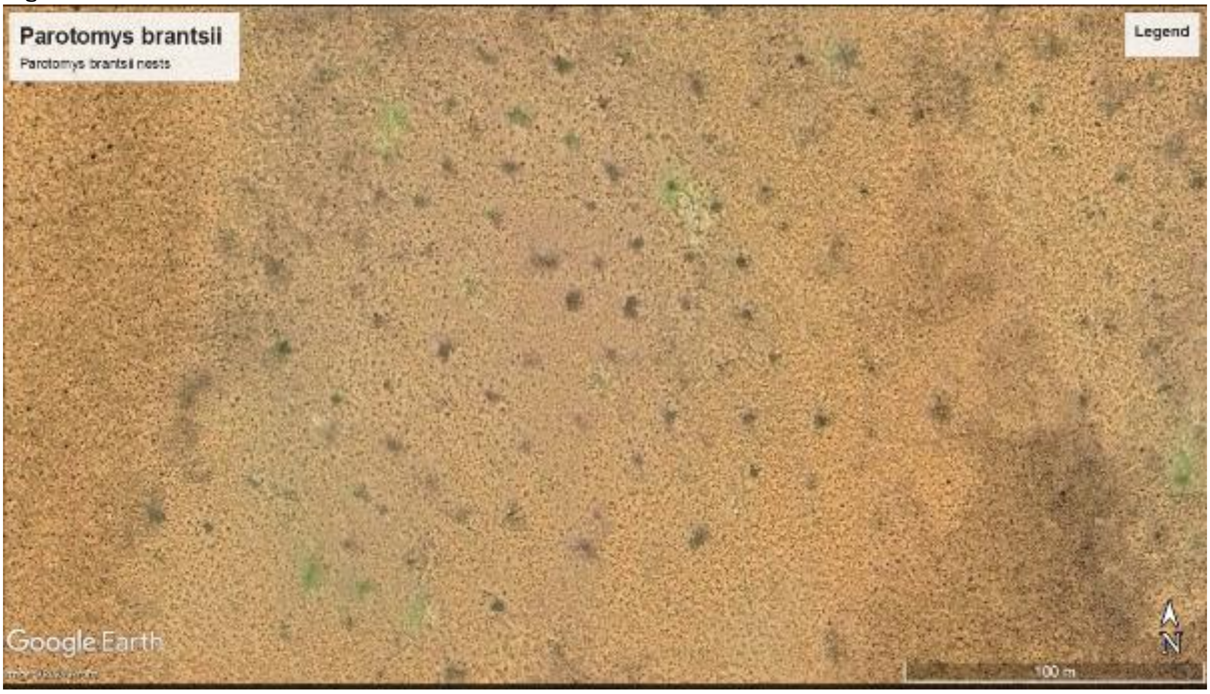


Image 15: Ground view of Brant's whistling rats nest/dens.

Image 16 © Google Earth: map showing distribution of brant's whistling rats dens and accociated vegetation within the development site. This is likely the largest population of the rat species in South Africa.

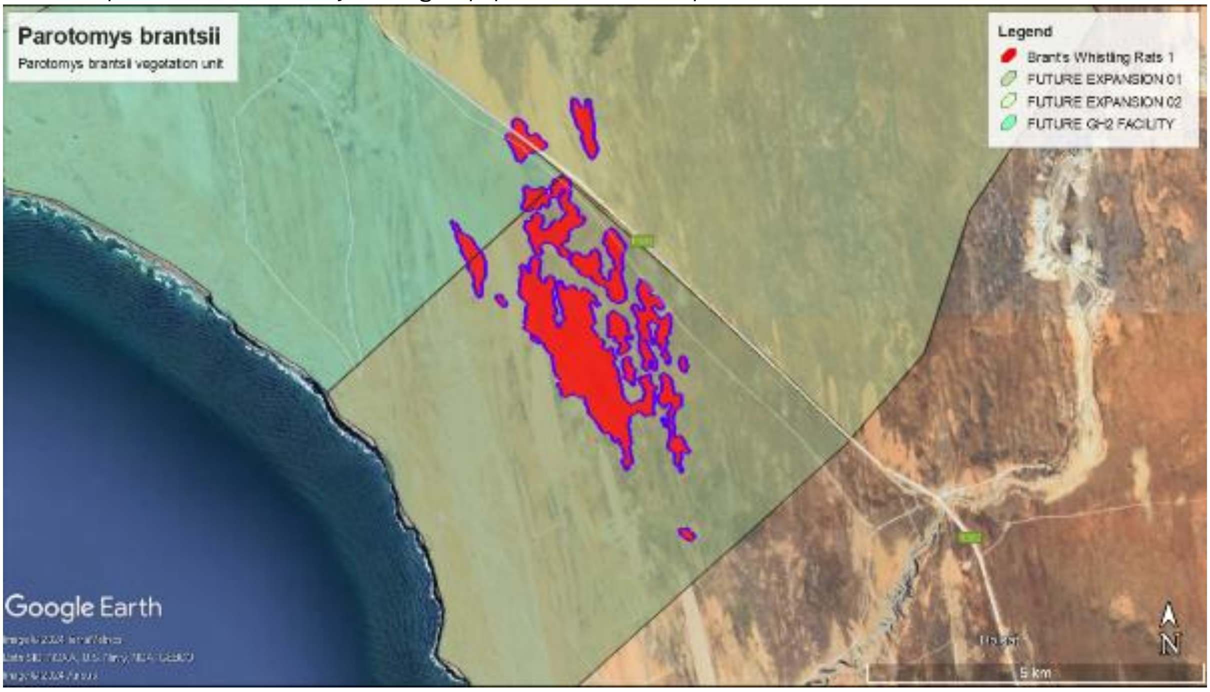


Image 17: picture showing less vegetated area of Heuweltjie, always associated with Mesembryanthemum and Eberlanzia plant species.

Image 18 © Google Earth: map showing distribution of heuweltjies, which forms par of the Richtersveld Scorpiontail vegetation units. This area is of high sensitivity, and found on the Swartbank to Holgat River area.

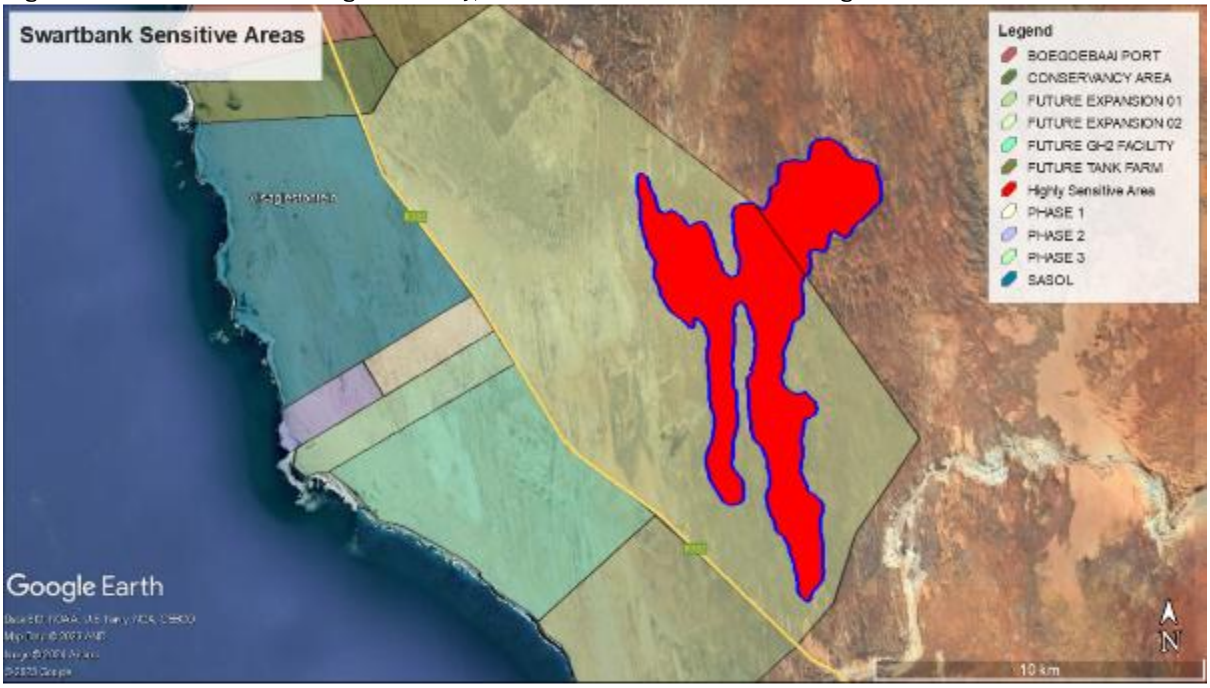


Image 19: dark material are termite fras always found in the centre of active heuweltjies.

Image 20: map of highly sensitive vegetation on Visagiesfontein hill.

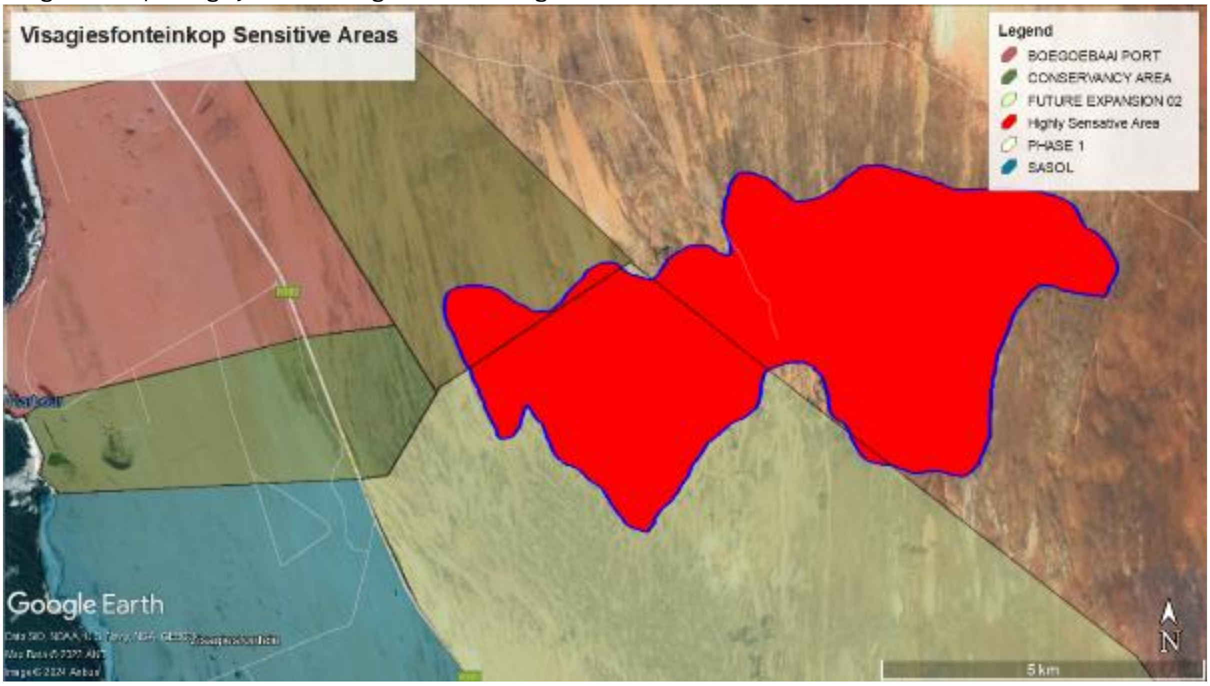


Image 21: Newly discovered Pelargonium from Visagiesfontein hill by the author of this report.

DISCUSSION: SENSITIVITY OF THE DEVELOPMENT SITE

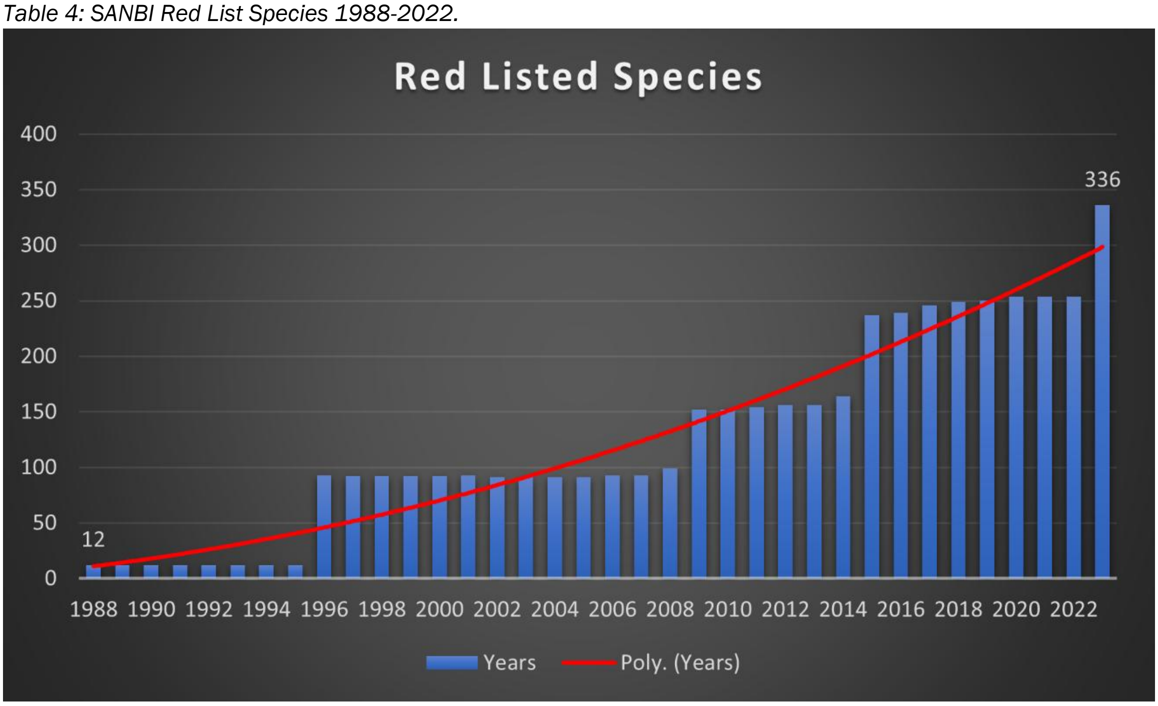
During the botanical survey several new and rare discoveries were made on both fauna and flora. From the data collected I was able to map sensitive habitats as well as habitats which are not sensitive. Habitats with low sensitivity is because of past and present mining impacts. There are large sections of vegetation, where not more than 10 species of plants occur, of which non has threatened status, and in some cases, there are large areas in the mine which has no plants, insects nor birds, due to past mining damage. These areas trigger no environmental conservation red tape and should be chosen for development in the future (*see images 22-24*).

Combining my data from the recent survey with that of 22 years of collecting data in the Richtersveld area, I could create a map showing the medium to high sensitivity areas of the whole Richtersveld region, which should not be considered for any further development or human induces stresses, in red, and the areas in yellow, are biodiversity-dead areas due to past disturbances, with little to no chance of ever recovering (*see image 25*).

The high plant taxa within this study site, as well as the high number of species of conservation concern, highlights the importance of this site for conservation. The areas not destroyed by mining directly or indirectly are still of high sensitivity and should not be developed. Overall keeping in consideration the high species numbers, any form of development in a region such as this can be devastating to the environment.

Important to note is the overall sensitivity of the landscape chosen for this large-scale development. The Richtersveld Municipal area already suffered a lot under land use changes and climate change. In Table 4 are an example of how the number of species being threatened has grown for the Richtersveld between 1988-2022. Due to the development of the Boegoebaai Port and green energies, including all secondary developments because of the future establishment of the port, more than 100 species additionally will be listed, making the Richtersveld the locality with the highest number of threatened species on the African continent (Van Wyk personal observation).

Table 4: SANBI Red List Species 1988-2022.



Regarding sensitivity of the lichen fields, even if not within the direct foot print of the port, are the following case study: In the 1800s independent observations in England, Munich, and Paris documented that lichens were already disappearing from urban areas. By the early 1900s this "city" effect was a widely recognized phenomenon in Europe and was first attributed to coal dust, which was emitted by most homes as well as many industries. Only later did the colourless gas, sulphur dioxide, become recognized as a principal phytotoxic agent. Today the list of air pollutants is much longer and includes oxidants, hydrogen fluoride, some metals (Section 12.7), acid rain, and organics. Certainly, the list of potentially toxic substances is not yet fully circumscribed. The high sensitivity of lichens is related to their biology. Most species live for decades or hundreds of years and a few longer; thus, as perennials, they are subject to the cumulative effect of pollutants. Lichens have no vascular system for conducting water or nutrients; as a consequence, they have developed efficient mechanisms for taking up water and nutrients from atmospheric sources. Fog and dew are major water sources for lichens, often have much higher pollutant concentrations than precipitation, and the lichens' nutrient concentration mechanisms also will concentrate pollutants. Unlike many vascular plants, lichens have no deciduous parts, and hence cannot avoid pollutant exposure by shedding such parts (Hawksworth 1971; Nimiset al. 2002, Nash, T.H., III 2008). There is evidence that the nearby tar road between Port Nolloth and Alexander bay has had a negative effect on the Alexander bay Lichen Fields due to air pollution by vehicles (Jurgens, Mucina and Rutherford 2006). An unknown lichen fields of almost equal importance also occurs on the south-western slopes of Boegoeberg hills which are currently being negatively impacted by mining. The proposed refineries of Oil and other mineral, as well increase air pollution by sea vessels, trains and more vehicle traffic could have a devastating effect on the lichen fields of the region.

The importance of biodiversity within the Richtersveld Municipality and some sections of the northern Nama Koi Municipality of the Northern Cape Province, cannot be stretched far enough. Scientific explorations especially over the past few decades provided evidence that vast areas of this region are of global importance due to high levels of endemism unlike elsewhere on earth. Regardless of the importance, recent research showed that this biodiversity hotspot is under immense pressure of degradation due to bad anthropogenic land use practices (Jurgens et al. 2025), which should raise great concerns for the region. Should mega developments such as the Boegoebaai port, railway, green energies and other developments roll out, not only in the Richtersveld Municipal area but also in the Sperrgebiet of Namibia.

Given the low rainfall, aridity and past damaged caused by the mines within the core development area, the higher plant taxa are still significantly high, indicating the uniqueness of the chosen locality for this development. Most species were recorded on rocky outcrops and in the area east of the Port Nolloth – Alexander Bay tar road, where mining impacts has been way less.

CONCLUSIONS

The Boegoebaai development area falls within a highly sensitive habitat, already severely impacted by 99 years of diamond mining. The locality for the ‘harbour’ or ‘port’, close to the Boegoeberg twin hills, should be shifted either to the north or south of these two mountains. The reason being that there is still natural vegetation between these two hills which contains unique endemic vegetation. The area between the two mountains, likely form a unique microclimate, due to the two hills forming a wind shelter, this could be observed by the high presence of lichens and snake species such as dwarf beaked snakes on the northern side of Boegoeberg South. Furthermore, the rocky areas overlooking the ocean, at the planned harbour wall site, contains the highest concentration of *Crassula plegmatoides* within the species distribution, removal of this population will have a detrimental impact on the species, as well as decrease in Namib Desert Lichen Fields within South Africa.

The rich lichen fields on the Boegoeberg twins and some other localities, as well as the Alexander Bay Lichen Fields, are of the most sensitive and bizarre habitats on earth, they are especially sensitive to air pollution. A study needs to be done on the dominant movement of air from the planned port site, to ensure that it does not move onto the Alexander Bay Lichen Fields, and what scale of air pollution will be created by this development, as this might also negatively impact all the western side of the Namib desert.

All areas with rocky outcrops within the development site, including the Boegoeberg twins, contains high concentrations of endemic plants as well as unique lichen communities and should not be touched. Some of these areas is of such importance, that the erecting of towers on them should not be considered at all.

A large section in the southern part of the scope area for this development host the largest colonies of brant’s whistling rats south of the Orange River, which has unique vegetation associated with them. Disturbances to these areas can lead to total collapse of ecosystems and should be avoid at all costs.

Furthermore, in the eastern side of the scope area, are unique vegetation associated with harvester termites, called heuweltjies. These ancient colonies of termites have slowly been driving unique evaluation of flora in the area and should not be disturbed at all costs.

The Visagiesfontein hill is the highest point in alleviation on the coastal plains of the Richtersveld. The hills have an ancient underlying dune, densely covered with vegetation, including lichens, which together forms a fog oasis, allowing such dense vegetation to exist in the arid northern coastline of South Africa. This vegetation hosts several endangered species, including some rare species only recently discovered. The dense vegetation on this hill also allows for high concentrations of fauna to survive, including one of the largest colonies of desert rain frogs (*Breviceps macrops*).

It is important to pay attention to the publication "A Perfect Storm" (Jurgens et al. 2025) which explains how easily small disturbances in a windy area such as Boegoeberg planed port area, can become catastrophic. At all costs, development should be limited only to the yellow areas as indicated in Image 22, to prevent an environmental catastrophe. Developing the yellow areas, could actually be of conservation importance and prevent the movement of sand from these areas into non disturbed areas east of the mines. It is however of great importance that air pollution needs to be limited, to prevent major die backs of lichens not only on Boegoeberge but all of the Namib Desert which air potentially could be impacted by Boegoebaai.

Image 22: map of low biodiversity areas which solely should be considered for future development.

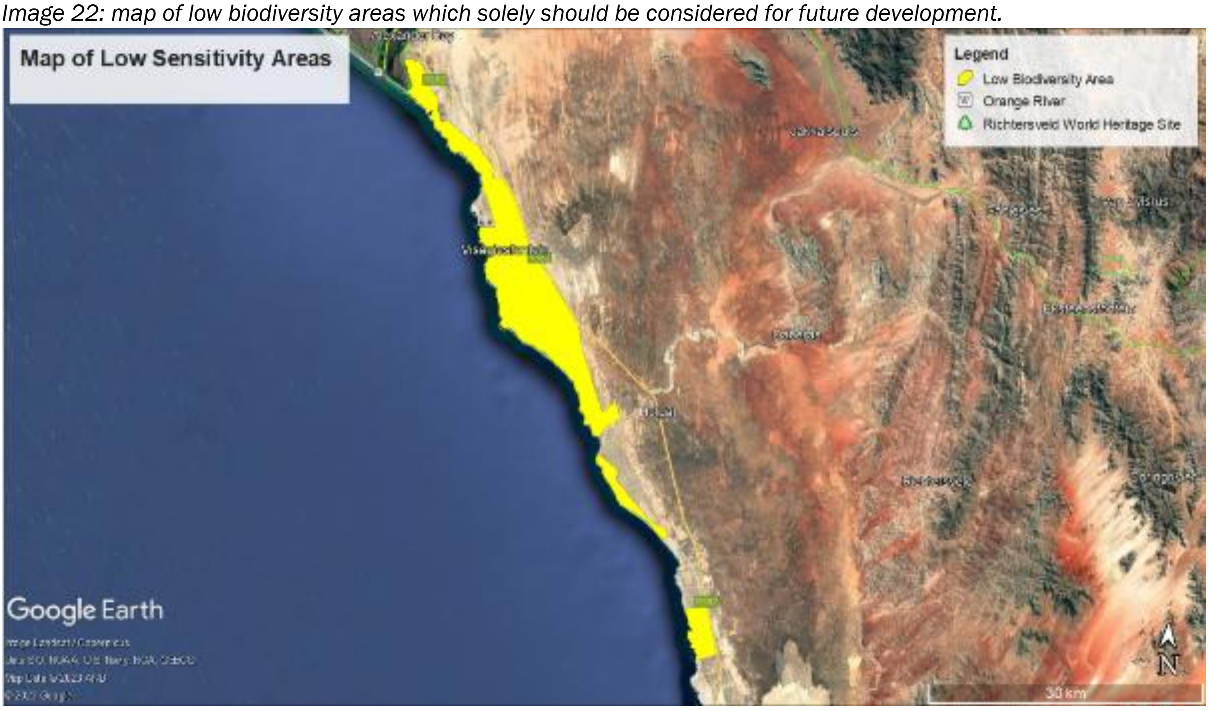


Image 23: map how high sensitive habitats which should not be considered for future development.

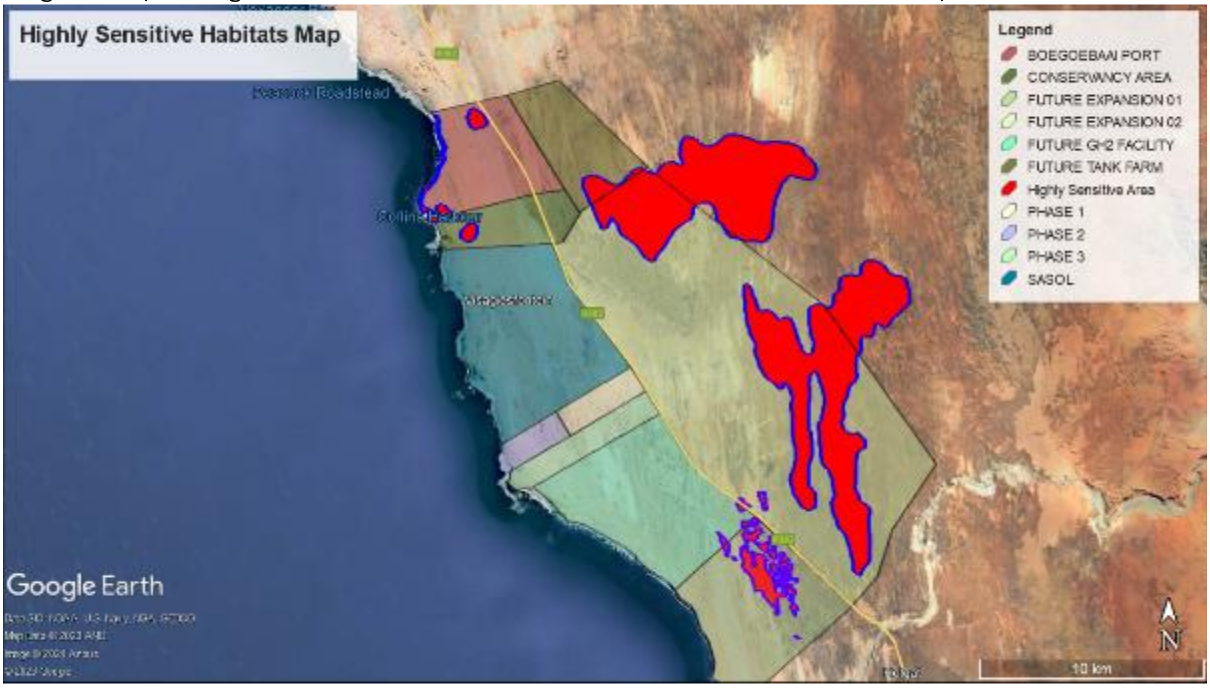


Image 24: map showing section of development area, in green which is medium sensitive, however needs to be compared with image 23 in this document. This green zone should not be considered for development, as it will have detrimental negative impacts on the high sensitivity areas.

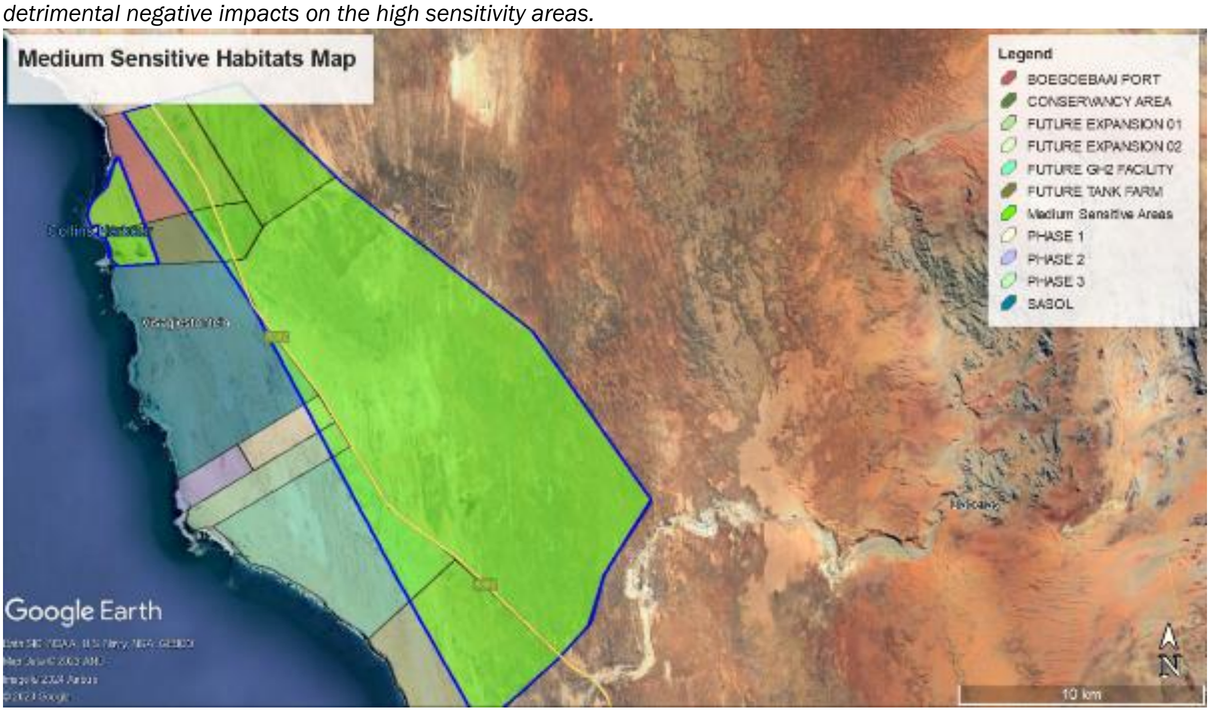


Image 25: Sensitivity map of the Richtersveld.

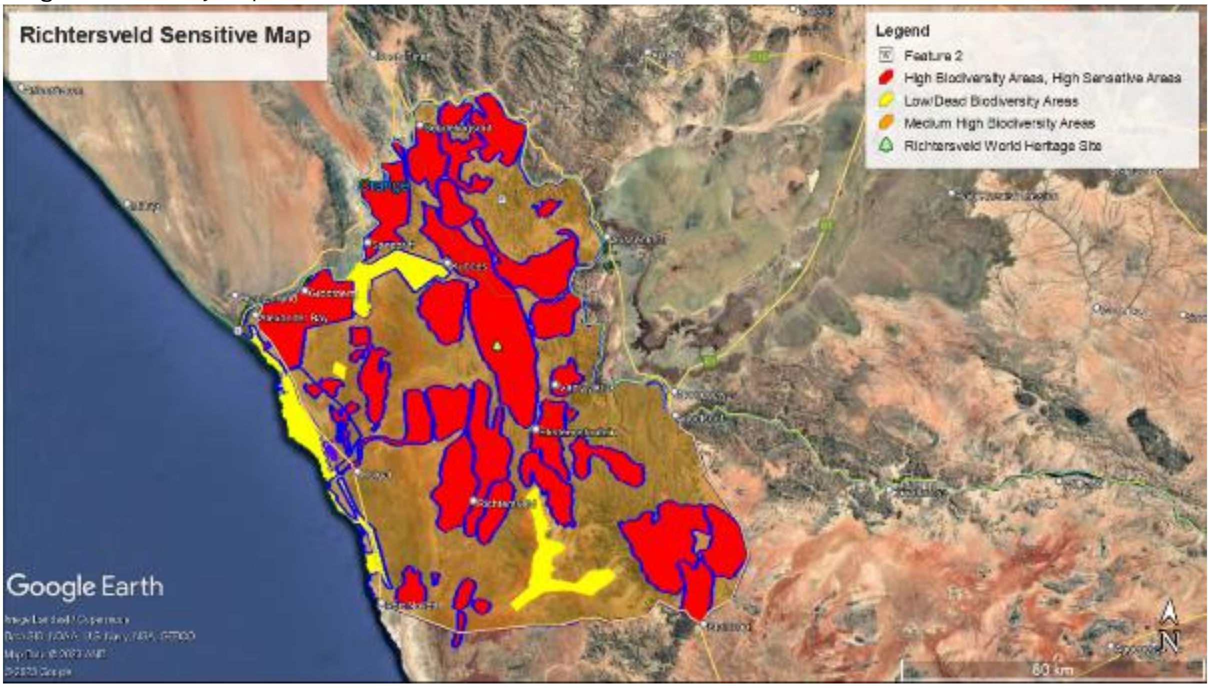
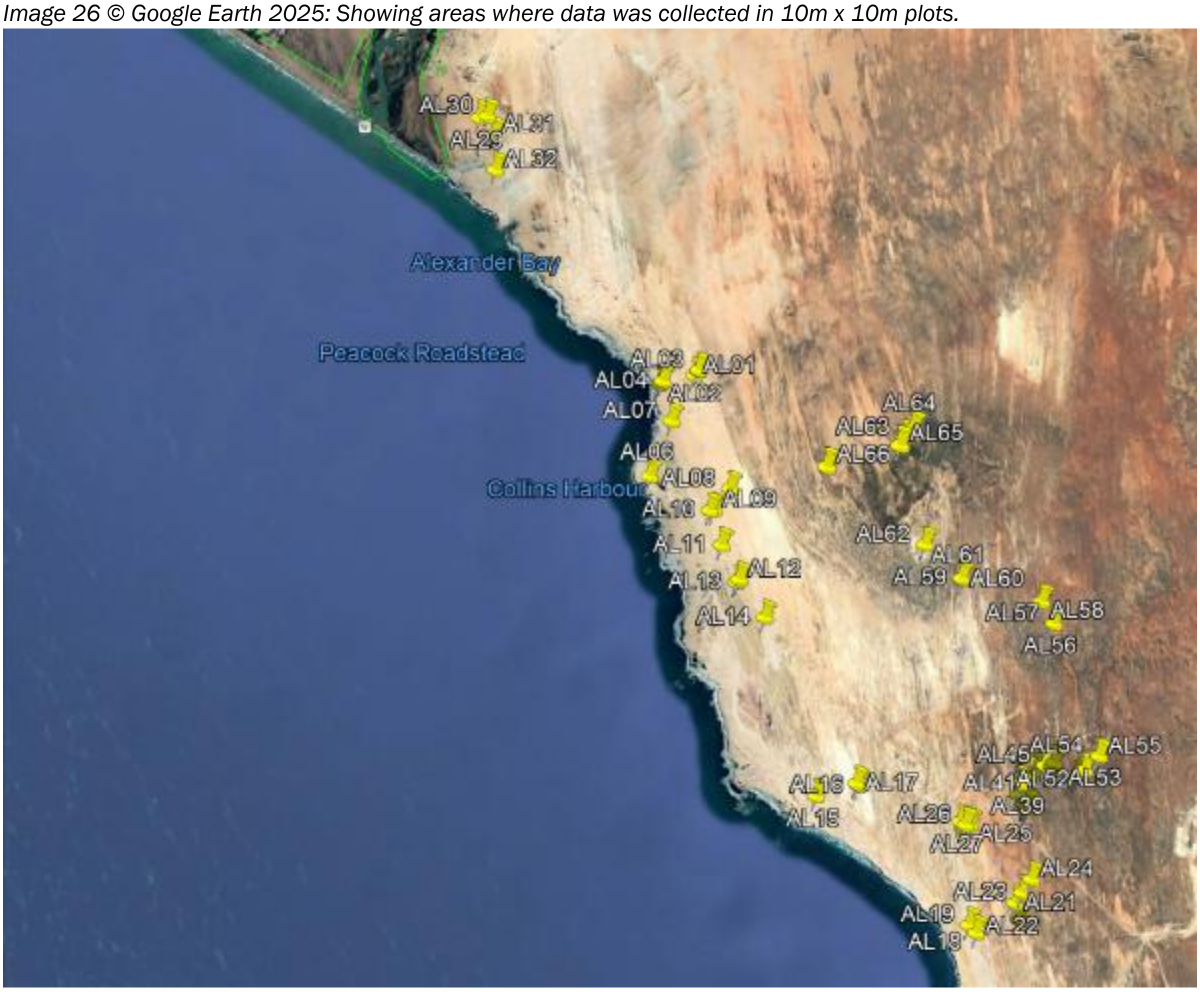


Image 26 © Google Earth 2025: Showing areas where data was collected in 10m x 10m plots.



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Appendix 1 Checklist of Plant Taxa Observed

Table 1: A List of the higher plant taxa observed. Total taxa observed = 331.

Taxon Name	Taxon Name	Taxon Name
Adenogramma glomerata	*Drosanthemum hispidum*	*Monsonia ciliata*
Adromischus marianiae var. *hallii*	*Drosanthemum inornatum*	*Monsonia luederitziana*
Adromischus montium-klinghardtii	*Drosanthemum luederitzii*	*Monsonia patersonii*
Aizoon crystallinum	*Eberlanzia cyathiformis*	*Monsonia patersonii*
Aizoon fruticosum	*Eberlanzia sedoides*	*Monsonia salmoniflora*
Aizoon pruinosum	*Enneapogon scaber*	*Moraea namibensis*
Aizoon sarcophylla	*Eriocephalus brevifolius*	*Myxopappus acutilobus*
Albuca cooperi	*Eriospermum namaquanum*	*Nemesia arenifera*
Albuca flaccida	*Euphorbia angrae*	*Nemesia bicornis*
Albuca grandis	*Euphorbia burmanii*	*Nemesia saccata*
Albuca maxima	*Euphorbia caput-medusae*	*Odyssea paucinervis*
Albuca sp. nov	*Euphorbia dregeana*	*Oncosiphon grandiflorum*
Albuca suaveolens	*Euphorbia ephedroides* var. *ephedroides*	*Oncosiphon suffruticosum*
Aloe arenicola	*Euphorbia ephedroides* var. *imminuta*	*Ophioglossum polyphyllum*
Aloe framesii	*Euphorbia ephedroides* var. *imminuta*	*Ornithogalum falcatum*
Amellus nanus	*Euphorbia hamata*	*Ornithoglossum dinteri*
Amellus tenuifolius	*Euphorbia mauritanica*	*Ornithoglossum parviflorum* var. *parviflorus*
Amphibolia rupis-arcuatae	*Euphorbia rhombifolia*	*Ornithoglossum vulgare*
Amphibolia succulenta	*Euphorbia stapelioides*	*Osteospermum microcarpum*
Anacampseros namaquensis	*Felicia microsperma*	*Osteospermum oppositifolium*
Anacampseros retusa	*Felicia namaquana*	*Osteospermum polycephalum*
Anthospermum dregei	*Fenestraria rhopalophylla* subsp. *aurantiaca*	*Othonna furcata*
Anthospermum spathulatum subsp. *spathulatum*	*Ferraria schaeferi*	*Othonna quercifolia*
Antimima paripetala	*Ferraria variabilis*	*Othonna undulosa (filicaule)*
Antimima perforata	*Foveolina dichotoma*	*Oxalis bullulata*
Antimima sp. *nov Boegoeberg*	*Frankenia pomonensis*	*Oxalis copiosa*
Antizoma miersiana	*Frankenia pulverulenta*	*Oxalis psammophila*
Apiaceae sp.	*Gazania schenckii*	*Oxalis sonderiana*
Aptosimum viscosum	*Gazania tenuifolia*	*Pelargonium adriaanii*
Arctotis canaliculata	*Gethyllis grandiflora*	*Pelargonium echinatum*
Arctotis sp. *nov*	*Gethyllis linearis*	*Pelargonium fulgidum*
Asparagus capensis var. *capensis*	*Gladiolus saccatus*	*Pelargonium grandicalcaratum*
Asparagus capensis var. *litoralis*	*Gladiolus viridiflorus*	*Pelargonium minimum*
Asparagus declinatus	*Grielum grandiflorum*	*Pelargonium moniliforme*
Asparagus exuvialis	*Grielum humifusum*	*Pelargonium parviflorum*
Asparagus graniticus	*Harveya squamosa*	*Pelargonium sibthorpiifolium*
Asparagus juniperoides	*Hebenstretia integrifolia*	*Pelargonium sp. nov*
Asparagus undulatus	*Hebenstretia parviflora*	*Peliostomum virgatum*
Atriplex vestita var. *appendiculata*	*Hebenstretia repens*	*Pharnaceum croceum*
Babiana hirsuta	*Hebenstretia robusta*	*Pharnaceum exiguum*
Babiana namaquensis	*Helichrysum dunense*	*Pharnaceum microphyllum*
Bulbine abyssinica	*Helichrysum hebelepis*	*Phragmites australis*
Bulbine ophiophylla	*Helichrysum herniarioides*	*Phyllopodium hispidulum*
Bulbine rhopalophylla	*Helichrysum leontonyx*	*Phyllopodium namaense*
Calobota angustifolia	*Helichrysum marmarolepis*	*Polygala leptophylla*
Calobota cinerea	*Helichrysum obtusum*	*Polygala mossii*
Calobota halenbergensis	*Heliophila cornuta* var. *squamata*	*Pteronia glabrata*
Capnophyllum leiocarpon	*Heliophila lactea*	*Pteronia onobromoides*
Caroxylon aphyllum	*Hermannia macra*	*Pteronia paniculata*
Caroxylon cf. pillansii	*Hermannia paucifolia*	*Quaqua armata* subsp. *maritima*
Caroxylon nollothensis	*Hermannia pfeilii*	*Quaqua inversa*
Caroxylon sp.	*Hermannia sp. nov*	*Radyera urens*
Caroxylon zeyheri	*Holothrix filicornis*	*Rhynchopsidium pumilum*
Centropodia glauca	*Holothrix cf. schlechteriana (possible new spec.)*	*Roepera cordifolia*

Taxon Name	Taxon Name	Taxon Name
Cephalophyllum compressum	*Hydnora africana*	*Roepera fusiforme*
Cephalophyllum ebracteatum	*Hyobanche sanguinea*	*Roepera morgsana*
Cephalophyllum rigidum	*Isolepis marginata*	*Roepera sp. nov*
Chaetobromus involucratus subsp. *dregeanus*	*Jamesbrittenia fruticosa*	*Ruschia cf. variabilis*
Cheiridopsis robusta	*Jamesbrittenia merxmuelleri*	*Ruschia fugitans*
Chenopodium murale	*Jordaaniella clavifolia*	*Ruschia pallens*
Chlorophytum viscosum	*Jordaaniella cuprea*	*Ruschia pollardii*
Chrysanthemoides incana	*Jordaaniella spongiosa*	*Ruschia* sp. (possible new)
Chrysocoma ciliata	*Jordaaniella uniflora*	*Salvia africana-lutea*
Cladoraphis cyperoides	*Juncus acutus* subsp. *leopoldii*	*Sarcocornia natalensis* var. *affinis*
Cladorapis spinosa	*Kedrostis psammophila*	*Schismum schismoides*
Coelanthum semiquinquefidum	*Kewa angrae-pequenae*	*Searsia longispina*
Colchicum irroratum	*Kewa salsoloides*	*Selago angustibractea*
Conicosia elongata	*Kohautia ramosissima*	*Selago namaquensis*
Conicosia pugoiniformis subsp. *alborosea*	*Lachenalia anguinea*	*Senecio abruptus*
Conophytum saxetanum	*Lachenalia klinghardtiana*	*Senecio aloides*
Cotula anthemoides	*Lachenalia xerophila*	*Senecio sarcoides*
Cotyledon orbiculatum subsp. *orbiculatum*	*Lampranthus otzenianus*	*Septulina glauca*
Crassothonna cylindrica	*Lampranthus stipulaceus*	*Solanum burchellii*
Crassothonna sedifolia	*Lapeirousia arenicola*	*Spergularia bocconi*
Crassothonna sparsiflora	*Lapeirousia barklyi*	*Spergularia media*
Crassula ammophila	*Lapeirousia macrospatha*	*Stapelia pulvinata*
Crassula atropurpurea var. *cultriformis*	*Lasiosiphon microphyllus*	*Stipagrostis ciliata* var. *capensis*
Crassula brevifolia subsp. *psammophila*	*Lavatera arborea*	*Stipagrostis obtusa*
Crassula columnaris subsp. *prolifera*	*Ledebouria undulata*	*Stipagrostis schaeferi*
Crassula deceptor	*Leipoldtia uniflora*	*Stoeberia beetzii*
Crassula elegans subsp. *elegans*	*Lessertia candida*	*Stoeberia frutescens*
Crassula expansa subsp. *pyrifolia*	*Lessertia frutescens* subsp. *frutescens*	*Stoeberia utilis*
Crassula muscosa var. *muscosa*	*Limeum fenestratum*	*Suaeda plumosa*
Crassula muscosa var. *obtusifolia*	*Limonium dyeri*	*Teloschistes capensis*
Crassula natans	*Lotononis falcata*	*Teloschistes puber*
Crassula plegmatoides	*Lycium bosciifolium*	*Tetraene clavata*
Crassula pseudohemisphaerica	*Lycium decumbens*	*Tetraene patenticaula*
Crassula rudolfii	*Lycium ferocissimum*	*Tetragonia cf. fruticosa*
Crassula subaphylla subsp. *subaphylla*	*Lycium tetrandrum*	*Tetragonia decumbens*
Crassula tetragona	*Lyperia triste*	*Tetragonia echinata*
Crassula tomentosa var. *tomentosa*	*Manochlamys albicans*	*Tetragonia fruticosa*
Crotalaria meyeriana	*Manulea altissima*	*Trachyandra bulbinifolia*
Curio crassicaulis	*Manulea androsacea*	*Trachyandra ciliata*
Curio radicans	*Manulea minuscula*	*Trachyandra falacata*
Curio sulcicalyx	*Melolobium adenodes*	*Tridentea pachyrrhiza*
Cynodon dactylon	*Mesembryanthemum arenosum*	*Tylecodon paniculatus*
Cynorhiza typica	*Mesembryanthemum barklyi*	*Tylecodon reticulatus* subsp. *reticulatus*
Cyperus marginatus	*Mesembryanthemum brevicarpum*	*Tylecodon schaeferianus*
Dasispermum hispidum	*Mesembryanthemum cf. subnodosum*	*Tylecodon similis*
Deverra denudata subsp. *aphylla*	*Mesembryanthemum crystalinum*	*Tylecodon wallichii* subsp. *eclonianus*
Dianthus namaensis	*Mesembryanthemum deciduum*	*Veltheimia capensis*
Didelta carnosa var. *tomentosa*	*Mesembryanthemum dinteri*	*Veltheimia capensis*
Dimorphotheca polyptera	*Mesembryanthemum hypertrophicum*	*Wahlenbergia androsacea*
Dimorphotheca sinuata	*Mesembryanthemum marlothii*	*Wahlenbergia annularis*
Dipcadi crispum	*Mesembryanthemum noticflorum*	*Wahlenbergia asparagoides*
Dischisma spicatum	*Mesembryanthemum occulatum*	*Wahlenbergia prostrata*
Dregeochloa pumila	*Mesembryanthemum pseudoschlichtianum*	*Zaluzianskya affinis*
Drimia barbata	*Mesembryanthemum quartziticus*	*Zaluzianskya benthamiana*
Drimia elata	*Mesembryanthemum serotinum*	*Ziziphus mucronata*
Drimia occultans	*Mesembryanthemum tetragonum*	
Drosanthemum curtophyllum	*Microloma sagittatum*	

Table 2: Checklist of lower plant taxa observed. Total taxa observed = 91.

Acarospora gypsi-deserti	*Heterodermia namaquana*	*Santessonia namibensis*
Acarospora luederitzensis	*Lecanographa subcaesioides*	*Staurothele dendritica*
Acarospora ochrophaea	*Lecanora panis-erucae*	*Teloschistes capensis*
Arthothelium desertorum	*Lecanora* sp.	*Teloschistes chrysocarpoides*
Buellia cf. *follmannii*	*Lecanora sphaerospora*	*Teloschistes chrysophthalmus*
Buellia cf. *stellulata*	*Lecanora substylosa*	*Teloschistes puber*
Buellia follmannii	*Lecanorsa* cf. *substylosa*	*Tephromela austrolitoralis*
Buellia halonia	*Lecidea sarcogynoides*	*Tephromela nashii*
Buellia incrustans	*Lecidella crystallina*	*Toninia australis*
Buellia inturgescens	*Lecidella placodina*	*Tornabea scutellifera*
Buellia procellarum	*Ledidea sarcogynoides*	*Tortula atrovirens*
Buellia sipmanii	*Niebla cephalota*	*Trentepohlia* sp.
Buellia sp.	*Opegrapha culmigena*	*Usnea* sp.
Buellia stellulata	*Parmotrema perlatum*	*Xanthodactylon alexanderbaaii*
Caloplaca bonae-spei	*Parmotrema reticulatum*	*Xanthodactylon flammeum*
Caloplaca cinnabarina	*Parmotrema* sp.	*Xanthodactylon inflatum*
Caloplaca elegantissima	*Pertusaria pseudomelanospora*	*Xanthodactylon turbinatum*
Caloplaca gyalectoides	*Pertusaria velata*	*Xanthoparmelia arrecta*
Caloplaca namibensis	*Peterjamesia circumscripta*	*Xanthoparmelia cf. dregeana*
Caloplaca renatae	*Placidium squamulosum*	*Xanthoparmelia cf. incomposita*
Caloplaca rubelliana	*Podaxis* sp.	*Xanthoparmelia dregeana*
Caloplaca sp.	*Polytrichum* sp.	*Xanthoparmelia equalis*
Chrysothrix granulosa	*Ramalina angulosa*	*Xanthoparmelia hottentotta*
Combea mollusca	*Ramalina canariensis*	*Xanthoparmelia hueana*
Dimelaena radiata	*Ramalina fimbriata*	*Xanthoparmelia incomposita*
Diploschistes actinostomus	*Ramalina lacera*	*Xanthoparmelia namibiensis*
Dploicia canescens	*Ramalina melanothrix*	*Xanthoparmelia tentaculina*
Flavoparmelia soredians	*Ramalina* sp.	*Xanthoparmelia walteri*
Flavoparmelia sp.	*Roccella montagnei*	*Xanthoria sipmanii*
Gloeocapsa sp.	*Santessonia hereroensis*	
Grimmia laevigata	*Santessonia lagunebergii*	

Table 3: List of Species of Conservation Concern. Status = SANBI Red Data status. Total Species of Conservation Concern = 51. Total Red List species observed = 36.

Taxon Name	Status	Taxon Name	Status
Adromischus marianiae var. *hallii*		*Jordaaniella clavifolia*	VU
Adromischus montium-klinghartii	VU	*Jordaaniella uniflora*	NT
Albuca sp. *nov*		*Lachenalia klinghardtiana*	VU
Aloe arenicola	NT	*Lapeirousia barklyi*	VU
Aloe framesii	NT	*Lapeirousia macrospatha*	VU
Amphibolia succulent	NT	*Lasiosiphon microphyllus*	
Antimima perforata	CR	*Leipoldtia uniflora*	
Antimima sp. *nov*		*Mesembryanthemum marlothii*	
Arctotis canaliculata		*Monsonia ciliata*	
Babiana namaquensis	VU	*Monsonia pattersonii*	VU
Bulbine ophiophylla	EN	*Moraea namibensis*	EN
Bulbine rhopalophylla	VU	*Nemesia arenifera*	
Crassula ammophila	NT	*Nemesia saccata*	VU
Crassula brevifolia subsp. *psammophila*	VU	*Pelargonium adriaanii*	VU
Crassula plegmatoides	VU	*Pelargonium* sp. *nov*	
Crotalaria meyeriana	NT	*Phyllopodium hispidulum*	EN
Dregeochloa pumila	CR	*Phyllopodium namaense*	VU
Drimia barbata	CR	*Polygala mossii*	NT
Drimia occultans		*Quaqua armata* subsp. *maritima*	
Eberlanzia sedoides		*Quaqua inversa*	
Euphorbia angrae		*Stapelia pulvinata*	
Frankenia pomonensis	VU	*Tridentea pachyrrhiza*	CR
Gazania schenckii	CR	*Tylecodon schaeferianus*	VU
Helichrysum dunense	VU	*Wahlenbergia asparagoides*	NT
Helichrysum tricostatum	NT	*Wahlenbergia erophiloides*	
Jamesbrittenia merxmuelleri	EN		