

Mozambique TIPAs Fieldwork Report

A Preliminary Botanical Survey to Support Biodiversity Conservation in the
Vilanculos Coastal Wildlife Sanctuary, Mozambique



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Background

The Vilanculos Coastal Wildlife Sanctuary (VCWS) is a privately managed protected area, established in 2002 in co-operation with the government of Mozambique. It covers an area of approximately 250,000 km², from the northernmost point of the São Sebastião Peninsula, south to S22° 20.545'. It lies approximately 19 km south-east of Vilanculos town and 13 km south of the Bazaruto Archipelago, (Magaruque Island); on the north-western and northern sides, it is bounded by ocean water of the Vilanculos Bay (Read et al. 2014).

Historically, the sanctuary was sparsely populated with subsistence farmers and fishermen. However, after it was classified as a protected area, a program of resettlement for those communities living inside the boundary was established. Until 2014, several communities were still present within the sanctuary boundaries, particularly on the north-eastern side of the peninsula where there are several fishing communities (Read et al. 2014). However, these households are currently outside of the boundary fence. The population around the sanctuary is currently estimated at approximately 5,000 people, residing in six communities, Marape, Chingonguene, Matsopane, Chibo, Chicuinine and Machuquele. As in many other rural regions of Mozambique, these communities are represented by community leaders who, among several other functions, provide the link for contact between the local communities and the management representatives of the sanctuary.

The mission of the VCWS is guided by the vision of maintaining a conservation area to preserve native terrestrial and marine biodiversity, as well as to provide benefits to local communities, without damaging the integrity of ecosystems. Ecological tourism initiatives have been developed as a means of generating positive impacts on biodiversity and well-being of the local communities around the sanctuary.

In 2004, the sanctuary started a program of fauna reintroductions, which would support ecotourism activities and increase biodiversity and the complexity of ecological interactions. The wildlife introduced to date include eland, gnu, piva, kudu, zebra, nyala, pala-pala, imbabala, giraffe and rhinoceros, although the last three have not survived, perhaps because they have not adapted favourably to the habitats. Species such as grey buck, red buck, suni and bush pig already occurred naturally and the latest inventories show significant population growth.

Botanical surveys on the São Sebastião Peninsula have been limited to date. Surveys conducted by Portuguese botanists during the colonial era revealed some species of interest, most notably the globally threatened *Ecbolium hastatum* and *Jatropha subaequiloba*, but these surveys were far from exhaustive. Over the past six years, extensive surveys have been conducted in the coastal zone of southern Mozambique by Alice Massingue (lead-author of this report) as part of her Ph.D. studies, which revealed that this northern part of Inhambane is particularly rich in plant diversity and endemism. However, due to time and logistic constraints, the São Sebastião Peninsula was not included in Dr. Massingue's surveys.

A checklist of the plants of the sanctuary has recently been compiled by Mark Read, a homeowner on the site and a keen botanist - this checklist has proven useful in the preparation for the current survey, and the plant lists will eventually be combined. As the site has not been subject to a full plant inventory to date, it is likely that further botanical surveys of the sanctuary will reveal additional plant species of high conservation concern.

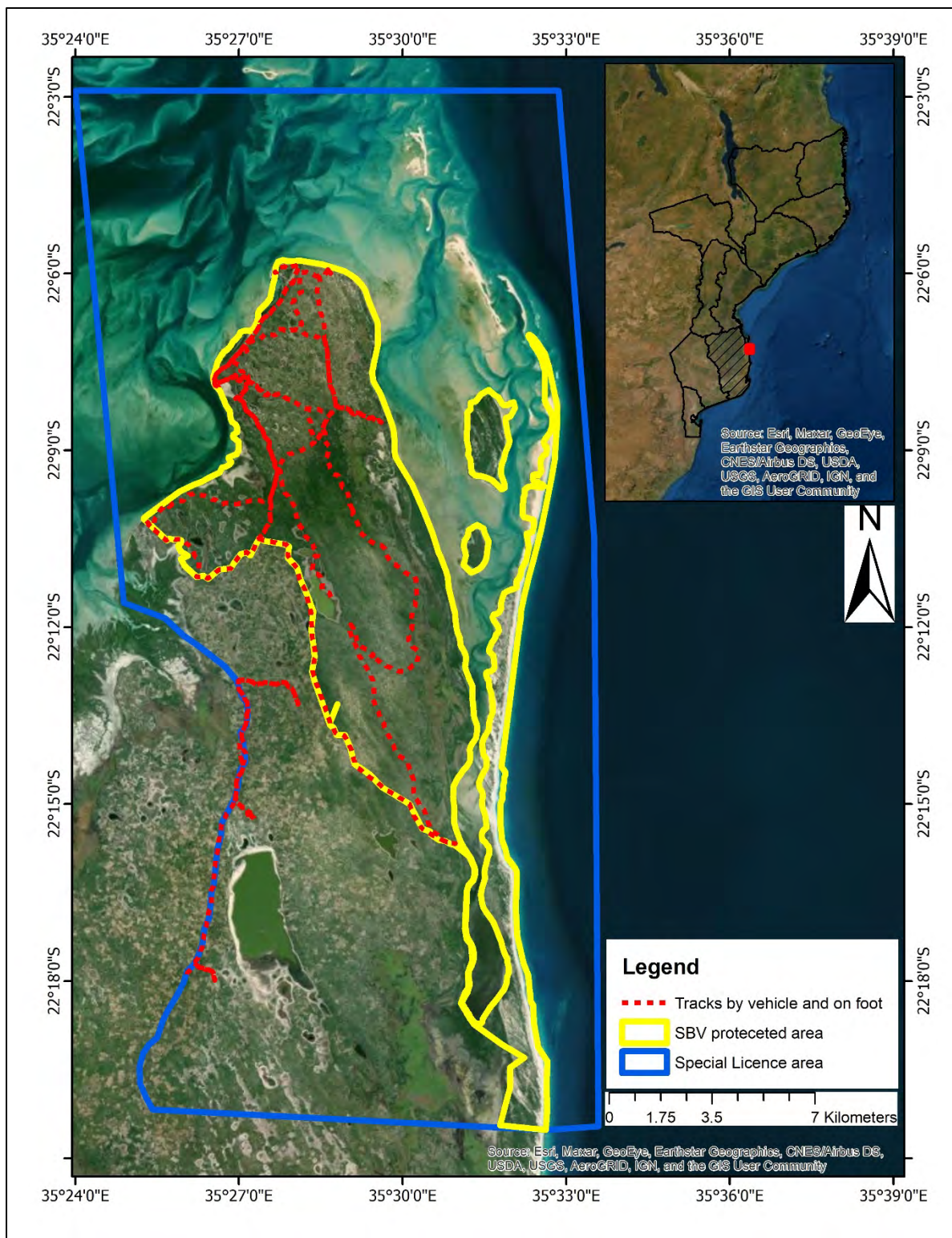


Figure 1. Botanical exploration in VCWS over six days of fieldwork (Map: C. Langa).

Aims

As with much of Mozambique, Inhambane province is relatively under-recorded botanically (Osborne et al., 2019). Given that the species of high botanical importance that occur within the VCWS boundaries were mostly known from old records, this fieldwork was carried out with the purpose of providing a preliminary survey of:

- the occurrence of endemic and near-endemic plants species;
- species of high conservation concern, or of socio-economic importance;
- threatened habitats and critical sites for these species; and
- exotic and potentially invasive species that may impact negatively on the natural habitats and critical species they contain.

Survey Methodology

The botanical expedition in the sanctuary and in the surrounding community lands located on the São Sebastião Peninsula took place on May 30 to June 6, 2021.

The survey team was made up of:

- Alice Massingue, Botanist from Universidade Eduardo Mondlane
- Castigo Datizua and Clayton Langa, Botanists from Instituto de Investigação Agrária de Moçambique (IIAM) and collaborators of the TIPAs Mozambique Project
- Bernaldo Melecuane, driver from IIAM
- Camilo Bruno, intern from Vilanculos Sanctuary
- Torres Vilanculos, ranger from Vilanculos Sanctuary.

The sampling was conducted through random transects inside and outside of the sanctuary, following paths between different types of habitats and environment scenarios, accessible with the vehicle and on foot (**Figure 1**). To ensure that all key habitats of the sanctuary and surrounding lands were covered, areas with particular characteristics - for example, dense and open forests, marshy areas and areas with signs of anthropogenic disturbance, etc. - were identified via Google Earth satellite imagery prior to the onset of the survey.

The exercise of localisation of these areas was carried out using Geographic Information Systems (GIS) technologies and a Global Positioning System (GPS) device to access the routes to the sampling points. In addition, historical areas of occurrence of endemic and/or near endemic species known from this site were investigated, in particular using the draft assessment of this site as a Tropical Important Plant Area (Richards et al., in prep.) and the associated plant diversity data held in herbaria. A total of 98 plant specimens were collected for identification and will be persevered at the National Herbarium of Mozambique (LMA) of the Agricultural Research Institute of Mozambique (IIAM) and in the Herbarium of the Royal Botanic Gardens, Kew (K).

Along the transects, observations were made in order to survey and characterise the area, including description of the type and characteristics of the habitat, composition and structure including the dominant species, presence or lack of endemic species and/or new records of species, and to assess the anthropogenic or natural disturbance to each habitat and the presence of the fauna; see **Figure 2**.

For vegetation classification mapping, Landsat 8 TM satellite imagery of year 2021 was obtained from www.glovis.usgs.gov. An image composed of all bands was formed, and a combination of bands was made, for later classification of images in ArcGIS Software version 10.3. A supervised image classification was performed, based mainly on the ground-truthed data obtained in the field including the coordinates of different vegetation types. This resulted in the classification of eight vegetation types, namely, closed miombo woodland, littoral dune, miombo forest, lagoon vegetation, mangrove, open miombo woodland, swamp, and coastal thicket. However, this classification needs further improvements and should be considered preliminary.



Figure 2. The fieldwork team on survey: top left, surveying a disturbed area (Photo: C. Datizua); top right: Datizua helping to prepare *Cocos nucifera* leaves to cover local house ceilings while interviewing local residents; bottom left, thicket on coastal dune along the boundary fence of the sanctuary; bottom right, species inventory within miombo woodland (Photo: C. Langa).

Findings & Discussion

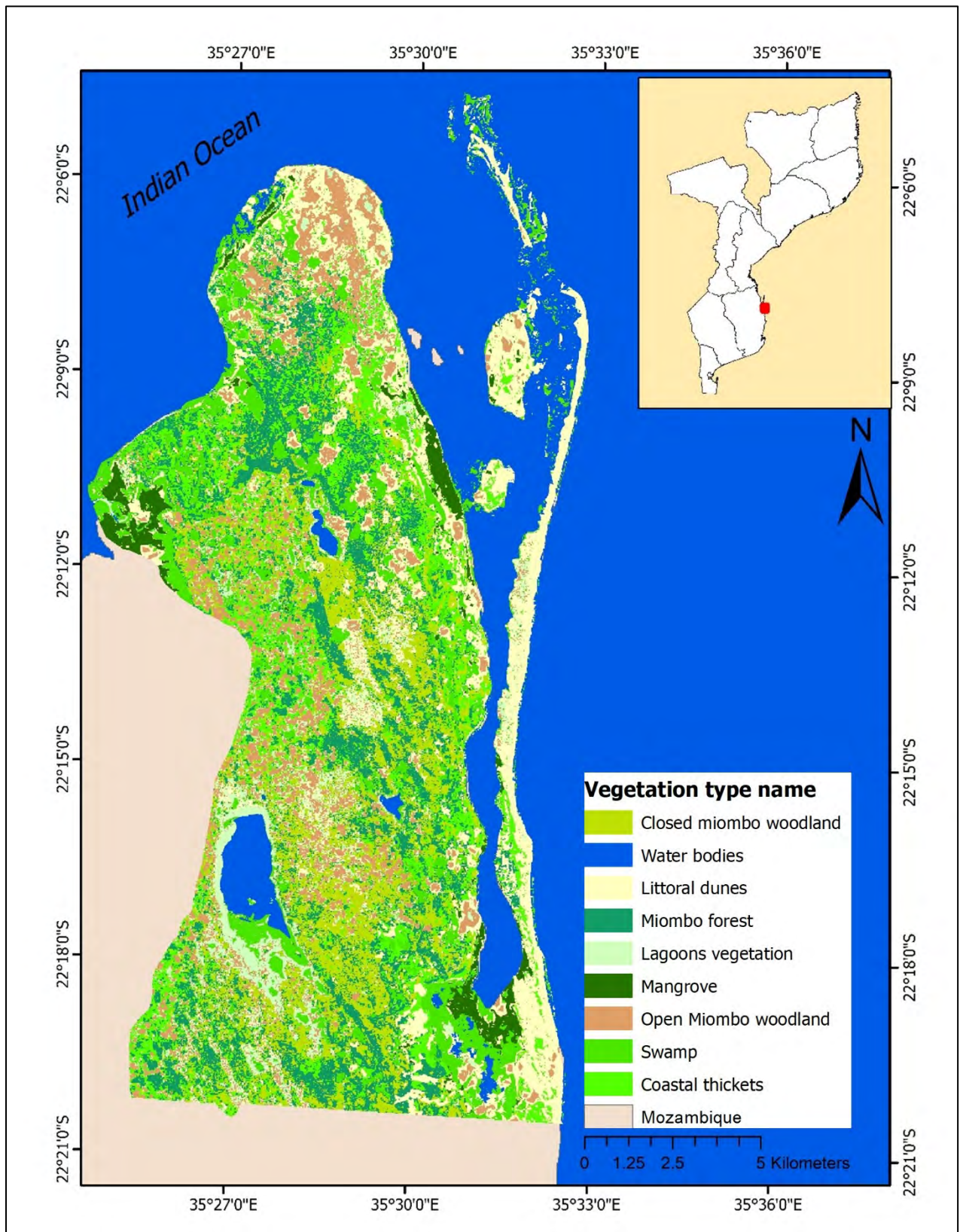


Figure 3: Preliminary vegetation map of the Vilanculos Coastal Wildlife Sanctuary (Map: C. Langa). The vegetation types are mapped separately in Appendix 3, Figures 19–26.

Vegetation characterization

A variety of habitats was observed in Vilanculos Sanctuary including terrestrial, aquatic, and marine, among them are mangroves, littoral dunes, miombo and wetlands (**Figure 3** - the habitats are mapped separately in Appendix 3, **Figures 19–26**). Wetlands in this area comprise mostly four permanent lakes (Nhone, Manhale, Xiveve and Sungudziva) and several seasonal lagoons. Miombo habitats observed are diverse and include miombo on primary dunes, open miombo woodland, closed miombo woodland, miombo forest, and thicket. It is notable that the miombo on primary dunes is unique from Inhassoro to Vilanculos districts in Mozambique (Massingue, 2019; Massingue et al. field work observation, 2021).

All types of vegetation and species composition were observed both inside and outside of the sanctuary, although outside of the boundary significant degradation was observed due to agriculture and settlements. The natural vegetation associated with most of the lagoons has been largely destroyed for agriculture. A full list of species encountered, per habitat, is provided in **Appendix 2**.

Mangroves

Mangrove is a loose term for halophytes that have adapted to living with their roots submerged for lengthy periods in seawater, although most have developed roots that remain above water for longer periods, enabling the plants to breathe. The main objective of this fieldwork was to explore inland vegetation. Therefore, observations on the mangrove communities were not detailed. The mangroves on the sanctuary are dominated by *Avicennia marina* and *Rhizophora mucronata*, with the rush *Juncus kraussii* abundant in the ground layer (**Figure 4**). A *Salicornia* sp. species was also recorded at this habitat, but without flowers or fruits present. Further research is needed in this area to confirm the identity of this species, as it may be *S. mossambicensis* which is endemic to Inhambane province.



Figure 4. Mangrove vegetation dominated by *Rhizophora mucronata* and the rushes *Juncus kraussii* (Photo: C. Langa).

Littoral dunes

Littoral dunes are very complex and are a common feature in southern Mozambique but are also found in Nampula province of northern Mozambique. In southern Mozambique these dunes occur from Inhassoro to Ponta de Ouro. The main species observed on the littoral dunes at the sanctuary are *Commiphora schlechteri*, *Craibia zimmermannii*, *Dichrostachys cinerea*, *Diospyros rotundifolia*, *Euclea natalensis*, *Grewia sulcata*, *Hyphaene coriacea*, *Mimosops caffra*, *Ochna natalitia*, *Ozoroa obovata*, *Sclerocarya birrea*, *Strychnos madagascariensis*, *Tricalysia delagoensis* and *Zanthoxylum delagoense* (**Figure 5**). Small colonies of the exotic *Opuntia monacantha* was also recorded on the littoral dunes. However, this exotic plant doesn't seem to be problematic to this vegetation.



Figure 5. The common littoral dune vegetation found along the coastline, top left (Photo: C. Langa); *Opuntia monacantha* on littoral dune vegetation, top right (Photo: C. Langa); common species of littoral dune, bottom (Photos: A. Massingue).

Coastal thickets

Coastal thickets observed in this study represent the same vegetation system found all along the southern coast of Mozambique, the main species observed in this type of vegetation were: *Albizia adianthifolia*, *Balanites maughamii*, *Mimusops caffra*, *Euclea natalensis*, *Tricalysia delagoensis*, *Acacia nilotica*, *Dialium schlechteri*, *Craibia zimmermannii*, *Manilkara mochisia*, *Manilkara discolor* and rarely *Azelia quanzensis*, etc. (see other taxa listed in **Appendix 2**) and some individuals of *Brachystegia spiciformis*, *B. torrei* and rarely *Julbernardia globiflora* were also observed (**Figure 6**).

A number of Mozambican endemic species can be found in this habitat, namely *Cissampelos hirta*, *Diospyros rotundifolia*, *Elaeodendron fruticosum*, *Psychotria* cf. *amboniana* subsp. *mosambicensis* and *Synaptolepis oliveriana*. and the near-endemics *Barleria delagoensis*, *Oxyanthus latifolius* and *Gymnosporia arenicola*.



Figure 6. Miombo thicket of *Brachystegia spiciformis* up to 10 m high. (Photo: C. Langa).

Miombo types

The most dominant species observed in this type of vegetation is *Julbernardia globiflora*, occupying about 90% of all the study area, followed by *Brachystegia spiciformis* and *B. torrei*. The dominant endemic species encountered are *Diospyros rotundifolia* and *Synaptolepis oliveriana*, which were recorded within all the miombo mosaics. No differences in species composition were recorded across the differing types of miombo vegetation, but they differ in vertical structure. Below the description of each type of miombo is noted.

Miombo on Primary Dunes

This type of miombo occurs only from Inhassoro to Vilanculos in southern Mozambique. The most dominant species in this type of vegetation can be either *Brachystegia spiciformis* or *Julbernardia globiflora*. This dune can be found both along the sea and along lagoons (e.g. lake Manhale located between -22.261957°, 35.458672° - see also section 4.1.5) - **Figure 7**. Large populations of the endemic *Chamaecrista paralias* are observed in this habitat. The others endemic species noted in this habitat are *Carpolobia suaveolens* and *Zanthoxylum delagoense*, and near-endemic species such as *Commiphora schlechteri* and *Ozoroa obovata* var. *elliptica*.



Figure 7. Miombo on primary dune dominated by *Brachystegia spiciformis* adjacent to a mangrove (Photos: C. Langa).

Open and closed miombo woodland

Open miombo woodland is dominated by *Julbernardia globiflora*, typically 2 to 5 m high, alternating with *Hyphaene coriacea* and *Garcinia livingstonei* (**Figure 8**). Sometimes a small cluster of *Julbernardia globiflora* and/or *Brachystegia spiciformis* occur in association with many other species found in the coastal zone, supporting the idea that these two miombo species can create a microhabitat that increases the diversity in the shaded areas which is higher than in the open areas (field observation).

These open areas are dominated by *Salacia kraussii* and the endemic *Chamaecrista paralias*; grass species such as *Digitaria cf. eriantha* and *Eragrostis* spp. are also common. The other endemic species recorded in this open miombo woodland are *Elaeodendron fruticosum* and *Triainolepis sancta* and near-endemic species such as *Cissampelos hirta* and *Ozoroa obovata* var. *elliptica*.



Figure 8. Open miombo woodland: left, with *Hyphaene coriacea* (Photo: A. Massingue); right, dominated by *Julbernardia globiflora* (Photo: C. Langa).

Closed miombo woodlands (**Figure 9**) were also found along the lagoons where the trees are typically ca. 5m high. The occurrence of the endemic species *Indigofera podophylla*, *Millettia ebenifera* and *Zanthoxylum delagoense* was noted in this habitat. The exotic *Agave sisalana* was also recorded but this exotic plant does not seem to be problematic to this vegetation at present.



Figure 9. Closed miombo woodland: left, dominated by *Julbernardia globiflora* (Photo: C. Langa); right, on climax of this habitat (Photo: A. Massingue).

Miombo forest

This type of miombo is mostly dominated by *Brachystegia spiciformis* with trees to ca. 10 m high, followed by *Julbernardia globiflora* and the presence of *Albizia versicolor* was also observed. Herbaceous species such as the near-endemic *Stapelia unicornis* were found in the sparse ground layer of this miombo. The exotic species *Agave sisalana* was also recorded in this habit outside of the sanctuary (22° 17'51.03"S, 35° 26'4.51"E), being widespread. This might be severely problematic outside the sanctuary, as it develops dense infestations, which can prevent the regeneration of trees and excludes indigenous species.



Figure 10. Top, Miombo forest climax community; bottom, an example of the large colonies of *Stapelia unicornis* in this habitat (Photos: C. Datizua).

Lagoons

The lagoon systems which occur within the Vilanculos Sanctuary are similar to those observed in all coastal regions from Ponta de Ouro up to the Save River (Massingue, 2019; field work observ., 2021), with fresh or brackish waters. Similar lagoons can also be observed in the coastal zone of Nampula province (A. Massingue, pers.obs. 2021).

In the Vilanculos Sanctuary, the main type of vegetation observed along the permanent lagoons is miombo characterised by *Julbernardia globiflora* as the dominant species. At ca. 50-100m from the water's edge, Cyperaceae species and *Chamaecrista paralias* are the most dominant, surrounded by miombo with about 5 to 10m height (**Figure 11**). In the ground layer, species of ferns were noted. Along the dunes associated with seasonal lagoons, the most dominant type of vegetation is open miombo woodland of *Julbernardia globiflora* and *Brachystegia spiciformis*, but also with other woody species such as *Syzygium cordatum*, *Garcinia livingstonei* and *Dichrostachys cinerea*, among others. In addition, as explained above, some dunes are covered with a short miombo, the same that is found along the coast on the primary dunes, dominated by *Julbernardia globiflora*.



Figure 11. Permanent lagoon with Cyperaceae species, surrounded by miombo vegetation (Photo: C. Langa).

Dune vegetation under degradation

An extension of about 1 km of the littoral dune vegetation along the northwest coast of the sanctuary (22° 5'49.14"S; 35° 28'19.24"E) is at imminent risk of disappearance due to the impact of erosion. Moreover, it seems that in the rainy season the problem will worsen further because the dune is very steep, hence the water will descend at high speeds. The soils are sandy red and not firm enough to contain the impact (see **Figure 12**).



Figure 12. Left, erosion impacts on the littoral dunes; right, the endemic *Chamaecrista paralias* at imminent risk by erosion impacts (Photos: C. Datizua).

Natural restoration of vegetation

Some areas of the sanctuary have previously been populated and therefore are still regenerating. These are now well recovered (**Figure 13**) and numerous native species are encountered in these seral communities, notably *Sclerocarya birrea*, *Gardenia volkensii*, *Vangueria lagiantha*, *Coptosperma nigrescens*, etc., and including the endemics *Millettia ebenifera*, *Chamaecrista paralias* and *Synaptolepis oliveriana*. The signals of human presence in the past include non-native species such as *Anacardium occidentale*, *Cocos nucifera*, *Mangifera indica* and *Syzygium* sp. and human implements, clay pots, and shellfish remains. However, these non-native species do not constitute a significant problem as they are mostly in a senescent stage.



Human activities

Although not encountered very often, some evidence of tree collection for construction poles or firewood, and some extraction of fibres for rope, both probably of *Julbernardia globiflora* were found inside the sanctuary (**Figure 14**). This suggests that local people still depend on the resources within the sanctuary, and they find these resources more available there than in the surrounding degraded habitats.



Figure 14. Top, parts of tree stems removed, for firewood and rope recorded inside of the sanctuary; bottom, fishing net inside of the sanctuary boundary (Photos: C. Datizua).

Of greater concern is the fact that many of the areas immediately outside the Vilanculos Sanctuary are degraded (**Figure 15**). The only areas of natural vegetation that appear intact are cemeteries, where people are only allowed to exploit firewood in small proportions. Cemeteries apparently provide a kind of protection for natural forests in these community lands.

These areas do not differ as much in terms of soil types as within the sanctuary, and the soil quality appears to be poor because of intense use. They are predominantly red sandy soils, interspersed with white sandy soils at some specific points, especially near the lagoons. The main type of vegetation encountered was miombo of *Brachystegia spiciformis* and *Julbernardia globiflora*.



Degraded mangrove communities outside the sanctuary

A line of about 800 meters of degraded mangrove can be observed outside the sanctuary within the Kewene Community (22° 10'4.25"S, 35° 25'19.91"E). This is one of the local communities that has been resettled. It is located along the northwest coast of Cape São Sebastião and depends entirely on fishing activity. According to local sources, before the relocation, this mangrove was ecologically healthy, and it seems likely that the mangrove stands have been gradually cut down for firewood and stakes for house construction.

At the same time, it is noted that the community depend upon the mangrove habitat for their fishing, because when the tide is high the fish hide between trees and the communities will throw their nets.

Remains of fishing net stretched among the few remaining mangrove tree can be observed (**Figure 16**).



Figure 16. Severally degraded mangrove communities outside of the Vilanculos Sanctuary (Photo: C. Datizua).

Exotics and Invasive species

Potentially the most problematic species found inside sanctuary was the native *Cassytha filiformis*. Whilst it seems that this species is not properly invasive, it is parasitic and can form dense sprawling colonies over the vegetation. In order to control the *Cassytha filiformis* propagation, the sanctuary has been actively clearing this species. *Agave sisalana* was observed at some points inside the reserve but only in small colonies (see the coordinates point). Outside the sanctuary, however, *Agave sisalana* is the most dominant invasive species (**Figure 17**).



Figure 17. *Agave sisalana* in miombo forest outside of the sanctuary boundary (Photo: C. Langa).

Endemic and threatened species

A total of 21 species of endemic and near endemic species for Mozambique were observed in the sanctuary. Of these species, *Chamaecrista paralias* and *Synaptolepis oliveriana* are common and were observed in all types of habitats, whilst *Ecbolium hastatum* was found in only in one location within the sanctuary (miombo forest habitat), and *Stapelia unicornis* was found only in one location (miombo forest) outside of the sanctuary. The distributions of the globally threatened species found to be present on the Peninsula are displayed in **Figure 18**.

Two further highly localised endemic species were also specifically targeted in these surveys, namely *Jatropha subaequiloba* (which has previously been recorded at this site) and *Memecylon insularis* (which occurs on nearby Magaruque Island, the only known site for this species globally), but these species were not seen during this expedition. Further surveys are needed to confirm the continued presence of the former species and the possible presence of the latter.

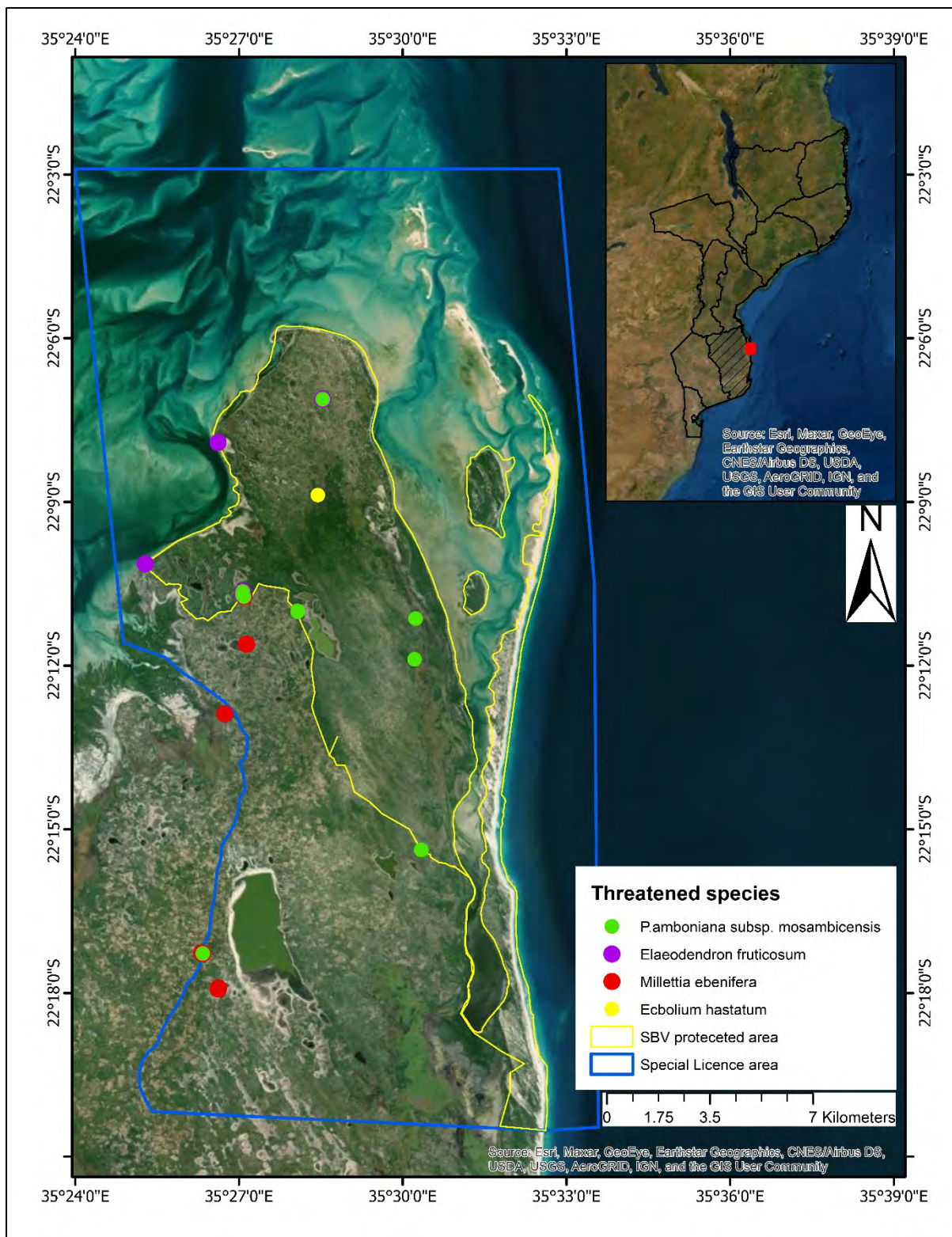


Figure 18: Occurrence map of Mozambican endemic and threatened plant species recorded in the sanctuary (Map: C. Langa).

Study Limitations

To carry out this fieldwork, the only limitation that the team faced was to get access to some areas outside the Sanctuary so that they could thoroughly explore the coastal zone of these areas and compare with the composition and diversity within the sanctuary. A review of Google Earth imagery revealed several areas with intact vegetation that have the potential to host a diversity of plant species. However, the team was unable to explore these areas in the short timeframe of this preliminary survey.

Acknowledgements

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Bibliographical References

- Massingue, A.O. (2019). Ecological Assessment and Biogeography of Coastal Vegetation and Flora in Southern Mozambique. PhD Thesis. Nelson Mandela University, Port Elizabeth.
- Osborne, J., Langa, C., Datizua, C., & Darbyshire, I. (2019). Inhambane Province – Panda, Mabote and Lagoa Poelela, Jan-Feb 2019. April, 1–17.
- Read, C., W. R. Tarboton, G.B.P. Davies, M.D. Anderson & T.A. Anderson (2004). An Annotated Checklist of Birds of the Vilankulos Coastal Wildlife Sanctuary, Southern Mozambique. *Ornithological Observations*, 5: 370-408.
- Richards, S. *et al.* (in prep.). Tropical Important Plant Areas of Mozambique: São Sebastião Peninsula.

Appendix

1. Mozambican endemic and near-endemic plant species recorded in the sanctuary during the May-June 2021 survey. For the IUCN threat assessment: EN = Endangered, VU = Vulnerable, LC = Least Concern, DD = Data Deficient.

N	Taxon	Frequency	IUCN Threat Assessment (if evaluated)	Endemic (E) / Near-Endemic (NE)
1	<i>Barleria delagoensis</i> Oberm.	Occasional		NE
2	<i>Carpolobia suaveolens</i> Meikle	Occasional	LC	E
3	<i>Chamaecrista paralias</i> (Brenan) Lock	Abundant	LC	E
4	<i>Cissampelos hirta</i> Klotzsch	Occasional	LC	NE
5	<i>Commiphora schlechteri</i> Engl.	Common		NE
6	<i>Crotalaria dura</i> subsp. <i>mozambica</i> Polhill	Scarce	LC	NE
7	<i>Diospyros rotundifolia</i> Hiern	Common		NE
8	<i>Ecbolium hastatum</i> Vollesen	Scarce	EN	E
9	<i>Elaeodendron fruticosum</i> N.Robson	Frequent	VU	E
10	<i>Euphorbia ambroseae</i> var. <i>spinosa</i> L.C. Leach.	Scarce		NE
11	<i>Gymnosporia arenicola</i> Jordaan	Occasional	LC	NE
12	<i>Indigofera podophylla</i> Harv.	Occasional		NE
13	<i>Millettia ebenifera</i> (Bertol.) J.E.Burrows & Lötter	Frequent	VU	E
14	<i>Oxyanthus latifolius</i> Sond.	Occasional		NE
15	<i>Ozoroa obovata</i> var. <i>elliptica</i> R. Fern. & A. Fern.	Common		NE
16	<i>Psychotria</i> cf. <i>amboniana</i> K.Schum. subsp. <i>mosambicensis</i> (E.M.A.Petit) Verdc.	Occasional	VU B2ab(ii,iii,iv,v)	E
17	<i>Salicornia</i> cf. <i>mosambicensis</i> (Brenan) Piirainen & G.Kadereit	Rare	DD	E
18	<i>Stapelia unicornis</i> C.A.Luckh.	Occasional		NE
19	<i>Synaptolepis oliveriana</i> Gilg	Common		NE
20	<i>Triainolepis sancta</i> Verdc.	Occasional	LC	E
21	<i>Zanthoxylum delagoense</i> P.G.Waterman	Occasional	LC	E

2. Checklist of plant species encountered in each habitat within and outside of the sanctuary. (Identification of some species is ongoing.)

N	Family	Taxa	Habitat in regeneration	Degraded habitat	Mangrove	Lagoons	Open miombo woodland	Closed miombo woodland	Miombo on Primary Dunes	Coastal Thicket	Miombo Forest	Inside the sanctuary	Outside the sanctuary
1	Acanthaceae	Not Identified								1		1	
2	Acanthaceae	<i>Barleria delagoensis</i> Oberm.								1		1	
3	Acanthaceae	<i>Barleria repens</i> Nees	1				1		1	1	1	1	1
4	Acanthaceae	<i>Ecbolium hastatum</i> Vollesen									1	1	
5	Achariaceae	<i>Xylothea kraussiana</i> Hochst.								1		1	
6	Amaranthaceae	<i>Salicornia</i> cf. <i>mossambicensis</i> (Brenan) Piirainen & G.Kadereit				1				1		1	
7	Amaryllidaceae	<i>Scadoxus multiflorus</i> (Martyn) Raf. subsp. <i>multiflorus</i>									1	1	1
8	Anacardiaceae	<i>Anacardium occidentale</i> L.	1	1				1	1	1	1	1	1
9	Anacardiaceae	<i>Lannea antiscorbutica</i> (Hiern) Engl.						1			1	1	
10	Anacardiaceae	<i>Mangifera indica</i> L.	1	1						1	1	1	
11	Anacardiaceae	<i>Ozoroa obovata</i> (Oliv.) R.Fern. & A.Fern. var. <i>obovata</i>	1	1			1	1	1	1	1	1	
12	Anacardiaceae	<i>Ozoroa obovata</i> (Oliv.) R.Fern. & A.Fern. var. <i>elliptica</i> R. Fern. & A. Fern.					1	1	1			1	
13	Anacardiaceae	<i>Sclerocarya birrea</i> (A.Rich.) Hochst.	1				1	1	1	1	1	1	
14	Anacardiaceae	<i>Searsia natalensis</i> (Bernh. ex C.Krauss) F.A.Barkley					1			1	1	1	1
15	Annonaceae	<i>Annona senegalensis</i> Pers.	1							1		1	
16	Annonaceae	<i>Artabotrys brachypetalus</i> Benth.					1	1	1	1	1	1	1
17	Annonaceae	<i>Cleistochlamys kirkii</i> (Benth.) Oliv.					1		1	1		11	
18	Annonaceae	<i>Monanthes affra</i> (Sond.) Verdc.					1				1	1	
19	Annonaceae	<i>Monodora junodii</i> Engl. & Diels	1				1	1		1	1	1	1
20	Annonaceae	<i>Sphaerocoryne gracilis</i> (Oliv. ex Engl. & Diels) Verdc. subsp. <i>gracilis</i>						1		1	1	1	1
21	Apiaceae	<i>Centella asiatica</i> (L.) Urb.					1			1		1	

N	Family	Taxa	Habitat in regeneration	Degraded habitat	Mangrove	Lagoons	Open miombo woodland	Closed miombo woodland	Miombo on Primary Dunes	Coastal Thicket	Miombo Forest	Inside the sanctuary	Outside the sanctuary
22	Apocynaceae	<i>Acokanthera oblongifolia</i> (Hochst.) Benth. & Hook.f. ex B.D.Jacks.								1		1	
23	Apocynaceae	<i>Carissa macrocarpa</i> (Eckl.) A.DC.	1							1		1	
24	Apocynaceae	<i>Landolphia kirkii</i> Dyer ex Hook.f.	1				1	1	1	1	1	1	1
25	Apocynaceae	<i>Stapelia unicornis</i> C.A.Lückh.									1		1
26	Apocynaceae	<i>Strophanthus petersianus</i> Klotzsch					1	1					1
27	Apocynaceae	<i>Tabernaemontana elegans</i> Stapf		1			1	1				1	1
28	Araceae	<i>Zamioculcas zamiifolia</i> (Lodd.) Engl.	1					1		1		1	1
29	Arecaceae	<i>Cocos nucifera</i> L.	1	1			1			1		1	
30	Arecaceae	<i>Hyphaene coriacea</i> Gaertn.	1	1			1		1	1	1	1	
31	Arecaceae	<i>Phoenix reclinata</i> Jacq.	1				1	1	1	1	1	1	
32	Asparagaceae	<i>Agave sisalana</i> Perrine			1			1			1	1	1
33	Asparagaceae	<i>Asparagus falcatus</i> L.								1	1	1	
34	Asparagaceae	<i>Dracaena hyacinthoides</i> (L.) Mabb.								1	1	1	
35	Asparagaceae	<i>Sansevieria concinna</i> N.E.Br. (= <i>Dracaena spathulata</i> Byng & Christenh.)		1					1			1	
36	Asphodelaceae	<i>Aloe suffulta</i> Reynolds							1		1	1	
37	Asteraceae	<i>Brachylaena discolor</i> DC.											
38	Asteraceae	<i>Helichrysum cf. candolleianum</i> H.Buek					1					1	
39	Asteraceae	<i>Helichrysum kraussii</i> Sch.Bip.		1		1	1	1	1	1	1	1	1
40	Asteraceae	<i>Vernonia colorata</i> (Willd.) Drake					1	1	1			1	1
41	Boraginaceae	<i>Hilsenbergia petiolaris</i> (Lam.) J.S. Mill.									1	1	
42	Burseraceae	<i>Commiphora schlechteri</i> Engl.						1	1	1	1	1	1
43	Cactaceae	<i>Opuntia monacantha</i> Haw.		1					1			1	
44	Capparaceae	<i>Maerua triphylla</i> subsp. <i>pubescens</i> (Klotzsch) DeWolf							1			1	
45	Celastraceae	<i>Brexia madagascariensis</i> (Lam.) Thouars ex Ker Gawl.	1	1								1	

N	Family	Taxa	Habitat in regeneration	Degraded habitat	Mangrove	Lagoons	Open miombo woodland	Closed miombo woodland	Miombo on Primary Dunes	Coastal Thicket	Miombo Forest	Inside the sanctuary	Outside the sanctuary
46	Celastraceae	<i>Gymnosporia arenicola</i> Jordaan		1			1	1				1	1
47	Celastraceae	<i>Gymnosporia senegalensis</i> (Lam.) Loes.	1							1	1	1	
48	Celastraceae	<i>Elaeodendron fruticosum</i> N.Robson	1				1			1		1	
49	Celastraceae	<i>Salacia kraussii</i> (Harv.) Harv.	1	1			1	1	1			1	1
50	Clusiaceae	<i>Garcinia livingstonei</i> T.Anderson		1			1	1	1	1	1	1	
51	Clusiaceae	<i>Psorospermum febrifugum</i> Spach								1		1	
52	Colchicaceae	<i>Gloriosa superba</i> L.	1					1					1
53	Combretaceae	<i>Combretum butyrosum</i> (G.Bertol.) Tul.		1						1		1	
54	Combretaceae	<i>Combretum microphyllum</i> Klotzsch	1					1				1	1
55	Connaraceae	<i>Rourea orientalis</i> Baill.								1		1	
56	Convolvulaceae	<i>Cuscuta africana</i> Willd.	1				1	1		1	1	1	
57	Convolvulaceae	<i>Cuscuta campestris</i> Yunck.					1					1	
58	Cyperaceae	<i>Cyperus</i> sp.				1						1	
59	Ebenaceae	<i>Diospyros inhacaensis</i> F.White							1	1	1	1	
60	Ebenaceae	<i>Diospyros rotundifolia</i> Hiern					1	1	1	1	1	1	
61	Ebenaceae	<i>Euclea natalensis</i> A.DC.		1			1	1	1	1	1	1	
62	Ebenaceae	<i>Euclea racemosa</i> L. subsp. <i>schimperii</i> (A.DC.) F.White					1		1	1		1	
63	Erythroxylaceae	<i>Erythroxylum delagoense</i> Schinz	1				1	1	1	1	1	1	
64	Erythroxylaceae	<i>Erythroxylum emarginatum</i> Thonn.								1		1	
65	Euphorbiaceae	<i>Acalypha</i> sp.						1			1	1	1
66	Euphorbiaceae	<i>Euphorbia ambroseae</i> L.C. Leach var. <i>spinosa</i> L.C. Leach											
67	Euphorbiaceae	<i>Euphorbia lividiflora</i> L.C.Leach								1	1	1	
68	Euphorbiaceae	<i>Euphorbia tirucalli</i> L.											
69	Euphorbiaceae	<i>Maprounea africana</i> Müll.Arg.		1			1	1	1			1	
70	Euphorbiaceae	<i>Sclerocroton integerrimus</i> Hochst.						1		1		1	

N	Family	Taxa	Habitat in regeneration	Degraded habitat	Mangrove	Lagoons	Open miombo woodland	Closed miombo woodland	Miombo on Primary Dunes	Coastal Thicket	Miombo Forest	Inside the sanctuary	Outside the sanctuary
71	Euphorbiaceae	<i>Suregada zanzibariensis</i> Baill.					1	1	1	1	1	1	1
72	Fabaceae	<i>Abrus precatorius</i> L.					1				1	1	1
73	Fabaceae	<i>Acacia (Vachellia) karroo</i> Hayne								1		1	
74	Fabaceae	<i>Acacia (Vachellia) nilotica</i> (L.) Willd. ex Delile								1		1	
75	Fabaceae	<i>Acacia (Vachellia) robusta</i> Burch.									1	1	
76	Fabaceae	<i>Acacia (Senegalia) senegal</i> (L.) Willd. var. <i>leiorhachis</i> Brenan					1				1	1	
77	Fabaceae	<i>Acacia (Senegalia) welwitschii</i> Oliv. subsp. <i>delagoensis</i> (Harms) J.H.Ross & Brenan									1	1	
78	Fabaceae	<i>Afzelia quanzensis</i> Welw.								1		1	
79	Fabaceae	<i>Albizia adianthifolia</i> (Schumach.) W.Wight		1			1	1	1	1	1	1	1
80	Fabaceae	<i>Albizia versicolor</i> Welw. ex Oliv.	1				1	1		1	1	1	1
81	Fabaceae	<i>Brachystegia spiciformis</i> Benth.	1	1			1	1	1	1	1	1	1
82	Fabaceae	<i>Brachystegia torrei</i> Hoyle		1			1	1	1	1	1	1	1
83	Fabaceae	<i>Canavalia rosea</i> (Sw.) DC.		1									
84	Fabaceae	<i>Chamaecrista paralias</i> (Brenan) Lock	1	1		1	1	1	1	1	1	1	1
85	Fabaceae	<i>Craibia zimmermannii</i> (Harms) Dunn						1	1	1	1	1	
86	Fabaceae	<i>Crotalaria dura</i> J.M.Wood & M.S.Evans subsp. <i>mozambica</i> Polhill				1							1
87	Fabaceae	<i>Crotalaria monteiroi</i> Taub. ex Baker f.									1		1
88	Fabaceae	<i>Dialium schlechteri</i> Harms								1	1	1	
89	Fabaceae	<i>Dichrostachys cinerea</i> (L.) Wight & Arn.						1	1		1	1	
90	Fabaceae	<i>Guilandina bonduc</i> L.							1			1	
91	Fabaceae	<i>Indigofera podophylla</i> Benth. ex Harv.			1			1	1		1	1	1
92	Fabaceae	<i>Julbernardia globiflora</i> (Benth.) Troupin	1	1			1	1	1	1	1	1	

N	Family	Taxa	Habitat in regeneration	Degraded habitat	Mangrove	Lagoons	Open miombo woodland	Closed miombo woodland	Miombo on Primary Dunes	Coastal Thicket	Miombo Forest	Inside the sanctuary	Outside the sanctuary
93	Fabaceae	<i>Millettia ebenifera</i> (Bertol.) J.E.Burrows & Lötter	1	1			1	1	1	1	1	1	1
94	Fabaceae	<i>Mundulea sericea</i> (Willd.) A.Chev.							1	1		1	
95	Fabaceae	<i>Peltophorum africanum</i> Sond.						1				1	
96	Icacinaceae	<i>Apodytes dimidiata</i> E.Mey. ex Arn.										1	
97	Juncaceae	<i>Juncus kraussii</i> Hochst.			1	1						1	
98	Lamiaceae	<i>Clerodendrum robustum</i> Klotzsch var <i>robustum</i>	1					1					1
99	Lamiaceae	<i>Rothea microphylla</i> (Blume) Callm. & Phillipson								1	1	1	
100	Lamiaceae	<i>Vitex payos</i> (Lour.) Merr.						1		1		1	
101	Lamiaceae	<i>Vitex</i> sp.											
102	Lamiaceae	<i>Volkameria glabra</i> (E.Mey.) Mabb. & Y.W.Yuan								1		1	
103	Linaceae	<i>Hugonia orientalis</i> Engl.								1	1	1	1
104	Loganiaceae	<i>Strychnos gerrardii</i> N.E. Br.		1			1	1	1	1		1	
105	Loganiaceae	<i>Strychnos madagascariensis</i> Poir.	1				1	1	1	1	1	1	
106	Loganiaceae	<i>Strychnos spinosa</i> Lam.		1			1		1			1	
107	Loranthaceae	Not Identified					1	1				1	
108	Loranthaceae	Not Identified		1									
109	Malpighiaceae	<i>Acridocarpus natalitius</i> A.Juss. var. <i>natalitius</i>	1	1						1		1	
110	Malvaceae	<i>Grewia bicolor</i> Juss.									1	1	
111	Malvaceae	<i>Grewia sulcata</i> Mast.	1	1				1	1	1		1	1
112	Malvaceae	<i>Hibiscus tiliaceus</i> L.								1		1	
113	Meliaceae	<i>Trichilia emetica</i> Vahl	1					1		1	1	1	1
114	Meliaceae	<i>Turraea nilotica</i> Kotschy & Peyr.									1	1	1
115	Menispermaceae	<i>Cissampelos hirta</i> Klotzsch		1			1		1	1		1	

N	Family	Taxa	Habitat in regeneration	Degraded habitat	Mangrove	Lagoons	Open miombo woodland	Closed miombo woodland	Miombo on Primary Dunes	Coastal Thicket	Miombo Forest	Inside the sanctuary	Outside the sanctuary
116	Menispermaceae	<i>Tiliacora funifera</i> Oliv.							1			1	
117	Moraceae	<i>Ficus trichopoda</i> Baker								1		1	
118	Moraceae	<i>Maclura africana</i> (Bureau) Corner								1		1	
119	Myrtaceae	<i>Eugenia capensis</i> (Eckl. & Zeyh.) Harv.					1	1			1	1	
120	Myrtaceae	<i>Psidium guajava</i> L.					1	1	1			1	1
121	Myrtaceae	<i>Syzygium cordatum</i> Hochst. ex Krauss	1	1			1	1		1	1	1	
122	Myrtaceae	<i>Syzygium cumini</i> (L.) Skeels		1			1					1	
123	Ochnaceae	<i>Ochna atropurpurea</i> DC.						1	1	1	1	1	1
124	Ochnaceae	<i>Ochna natalitia</i> (Meisn.) Walp.	1				1	1	1	1	1	1	1
125	Olacaceae	<i>Olax dissitiflora</i> Oliv.					1				1	1	
126	Olacaceae	<i>Ximenia caffra</i> Sond.									1	1	
127	Oleaceae	<i>Jasminum fluminense</i> Vell.								1		1	
128	Orchidaceae	<i>Vanilla roscheri</i> Rchb.f.						1		1	1	1	
129	Orchidaceae	cf. <i>Satyrium breve</i> Rolfe/ <i>Satyrium hallackii</i> Bolus				1							1
130	Orchidaceae	<i>Cyrtorchis arcuata</i> (Lindl.) Schltr.						1		1		1	
131	Orchidaceae	<i>Eulophia petersii</i> (Rchb.f.) Rchb.f.						1			1	1	1
132	Orobanchaceae	<i>Sopubia</i> sp.							1			1	
133	Oxalidaceae	<i>Oxalis semiloba</i> Sond.								1		1	
134	Passifloraceae	<i>Schlechterina mitostemmatoides</i> Harms											
135	Pedaliaceae	<i>Dicerocaryum</i> (=Sesamum) <i>senecioides</i> (Klotzsch) Abels				1	1			1	1	1	1
136	Phyllanthaceae	<i>Antidesma venosum</i> E.Mey. ex Tul.	1							1	1	1	
137	Phyllanthaceae	<i>Bridelia cathartica</i> Bertol.	1							1	1	1	
138	Phyllanthaceae	<i>Hymenocardia ulmoides</i> Oliv.						1		1		1	
139	Phyllanthaceae	<i>Margaritaria discoidea</i> (Baill.) G.L.Webster									1	1	

N	Family	Taxa	Habitat in regeneration	Degraded habitat	Mangrove	Lagoons	Open miombo woodland	Closed miombo woodland	Miombo on Primary Dunes	Coastal Thicket	Miombo Forest	Inside the sanctuary	Outside the sanctuary
140	Phyllanthaceae	<i>Phyllanthus reticulatus</i> Poir.						1		1		1	1
141	Pinaceae	<i>Pinus patula</i> Schlttdl. & Cham.							1			1	
142	Polygalaceae	<i>Carpolobia suaveolens</i> Meikle					1		1	1	1	1	
143	Polygalaceae	<i>Securidaca longipedunculata</i> Fresen.						1				1	
144	Putranjivaceae	<i>Drypetes arguta</i> (Müll.Arg.) Hutch.								1		1	
145	Putranjivaceae	<i>Drypetes natalensis</i> (Harv.) Hutch.								1		1	
146	Rhamnaceae	<i>Scutia myrtina</i> (Burm.f.) Kurz											
147	Rubiaceae	<i>Afrocanthium racemosum</i> (S.Moore) Lantz var. <i>racemosum</i>									1	1	
148	Rubiaceae	<i>Canthium inerme</i> (L.f.) Kuntze						1		1	1	1	
149	Rubiaceae	<i>Catunaregam obovata</i> (Hochst.) A.E.Gonç.					1	1		1	1	1	
150	Rubiaceae	<i>Coptosperma littorale</i> (Hiern) Degreef	1	1			1	1		1	1	1	
151	Rubiaceae	<i>Coptosperma nigrescens</i> Hook.f.	1				1			1		1	
152	Rubiaceae	<i>Coptosperma supra-axillare</i> (Hemsl.) Degreef					1			1		1	
153	Rubiaceae	<i>Empogona allenii</i> Stapf											
154	Rubiaceae	<i>Empogona coriacea</i> (Sond.) Tosh & Robbr.											
155	Rubiaceae	<i>Gardenia ternifolia</i> subsp. <i>jovis-tonantis</i> (Welw.) Verdc.	1							1		1	
156	Rubiaceae	<i>Gardenia volkensii</i> K.Schum.					1					1	
157	Rubiaceae	<i>Heinsia crinita</i> (Wennberg) G.Taylor subsp. <i>parviflora</i> (K.Schum. & K.Krause) Verdc.						1					1
158	Rubiaceae	<i>Oxyanthus latifolius</i> Sond.		1						1	1	1	1
159	Rubiaceae	<i>Pavetta gracilifolia</i> Bremek.											
160	Rubiaceae	<i>Pavetta pumila</i> N.E.Br.									1		1
161	Rubiaceae	<i>Pavetta uniflora</i> Bremek.											

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162	Rubiaceae	<i>Psychotria</i> cf. <i>amboniana</i> K. Schum. subsp. <i>mosambicensis</i> (E.M.A. Petit) Verdc.								1		1	
163	Rubiaceae	<i>Psychotria</i> cf. <i>capensis</i> (Eckl.) Vatke	1				1	1		1		1	1
164	Rubiaceae	<i>Psychotria ealaensis</i> De Wild.											
165	Rubiaceae	<i>Psydrax locuples</i> (K.Schum.) Bridson								1	1	1	
166	Rubiaceae	<i>Psydrax obovatus</i> (Klotzsch ex Eckl. & Zeyh.) Bridson									1	1	
167	Rubiaceae	<i>Spermacoce</i> sp.											
168	Rubiaceae	<i>Triainolepis sancta</i> Verdc.											
169	Rubiaceae	<i>Tricalysia delagoensis</i> Schinz					1	1	1		1	1	
170	Rubiaceae	<i>Vangueria</i> cf. <i>dryadum</i> S. Moore											
171	Rubiaceae	<i>Vangueria lasiantha</i> (Sond.) Sond.	1				1			1	1	1	
172	Rutaceae	<i>Ptaeroxylon obliquum</i> (Thunb.) Radlk.								1		1	
173	Rutaceae	<i>Zanthoxylum delagoense</i> P.G.Waterman						1	1			1	
174	Salicaceae	<i>Casearia gladiiformis</i> Mast.											
175	Salicaceae	<i>Flacourtia indica</i> (Burm.f.) Merr.	1					1	1	1	1	1	
176	Salvadoraceae	<i>Salvadora persica</i> L.					1					1	
177	Sapindaceae	<i>Allophylus africanus</i> P.Beauv.					1				1	1	1
178	Sapindaceae	<i>Allophylus</i> sp.									1	1	1
179	Sapindaceae	<i>Blighia unijugata</i> Baker									1		1
180	Sapindaceae	<i>Cardiospermum</i> sp.					1					1	
181	Sapindaceae	<i>Haplocoelum foliolosum</i> (Hiern) Bullock subsp. <i>mombasense</i> (Bullock) Verdc.								1		1	
182	Sapindaceae	<i>Pancovia golungensis</i> (Hiern) Exell & Mendon											
183	Sapotaceae	<i>Manilkara discolor</i> (Sond.) J.H.Hemsl.								1		1	
184	Sapotaceae	<i>Manilkara mochisia</i> (Baker) Dubard					1			1		1	

N	Family	Taxa	Habitat in regeneration	Degraded habitat	Mangrove	Lagoons	Open miombo woodland	Closed miombo woodland	Miombo on Primary Dunes	Coastal Thicket	Miombo Forest	Inside the sanctuary	Outside the sanctuary
185	Sapotaceae	<i>Mimusops caffra</i> E.Mey. ex A.DC.		1			1	1	1	1	1	1	1
186	Sapotaceae	<i>Sideroxylon inerme</i> L.		1			1	1	1			1	
187	Sapotaceae	<i>Vitellariopsis marginata</i> (N.E.Br.) Aubrév.					1			1		1	
188	Solanaceae	<i>Solanum</i> sp.							1	1		1	
189	Thymelaeaceae	<i>Synaptolepis oliveriana</i> Gilg					1	1	1	1	1	1	1
190	Verbenaceae	<i>Lippia javanica</i> (Burm.f.) Spreng.	1					1					1
191	Vitaceae	<i>Cissus integrifolia</i> (Baker) Planch.						1		1		1	
192	Vitaceae	<i>Cissus quadrangularis</i> L.						1		1	1	1	
193	Vitaceae	<i>Rhoicissus revollii</i> Planch.					1	1	1		1	1	
194	Vitaceae	<i>Rhoicissus digitata</i> (L. f.) Gilg & M. Brandt	1					1					1
195	Zygophyllaceae	<i>Balanites maughamii</i> Sprague	1				1	1	1	1	1	1	1

3. Preliminary maps of the main vegetation types of the Vilanculos Coastal Wildlife Sanctuary

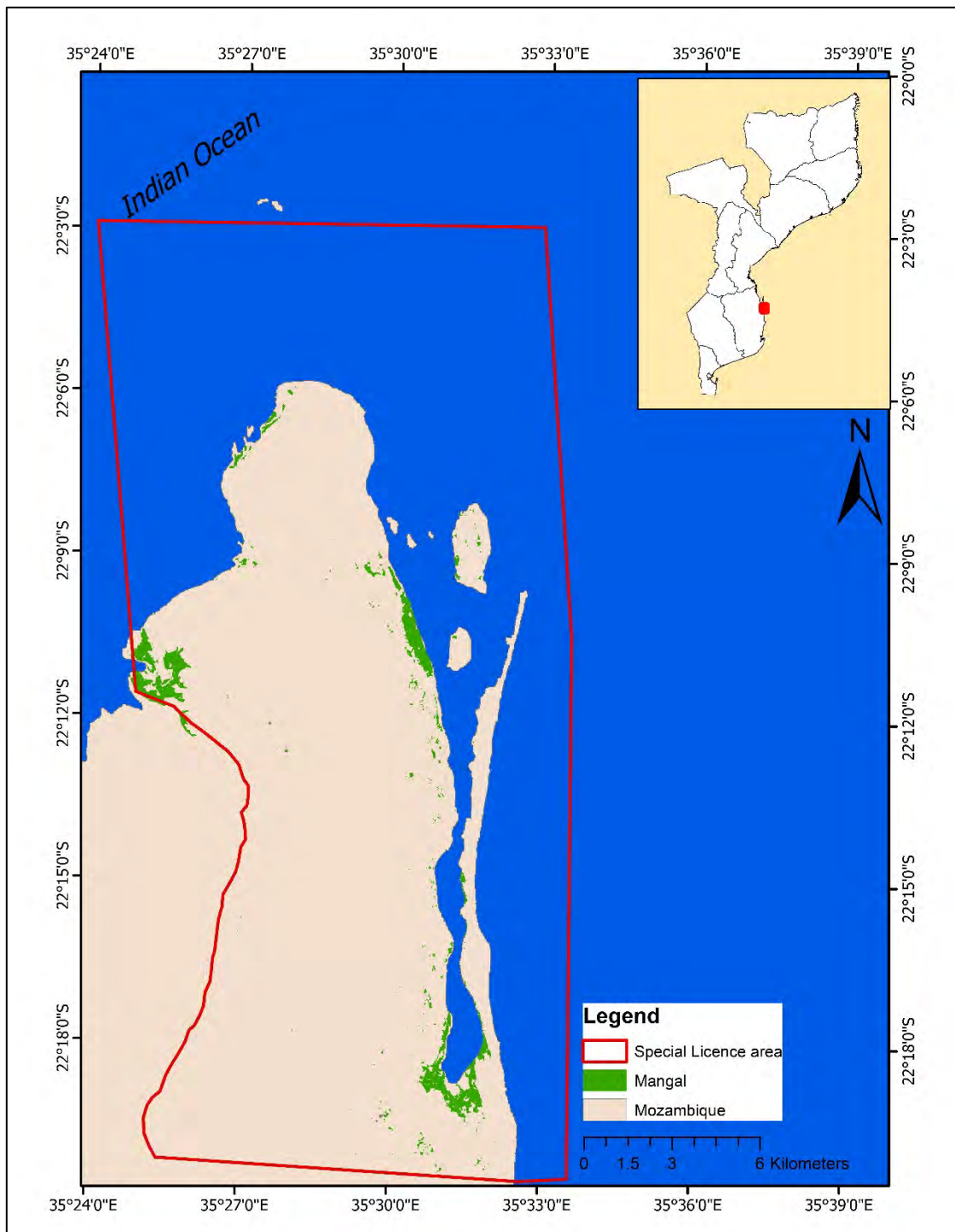


Figure 19: Preliminary map of the mangroves in VCWS

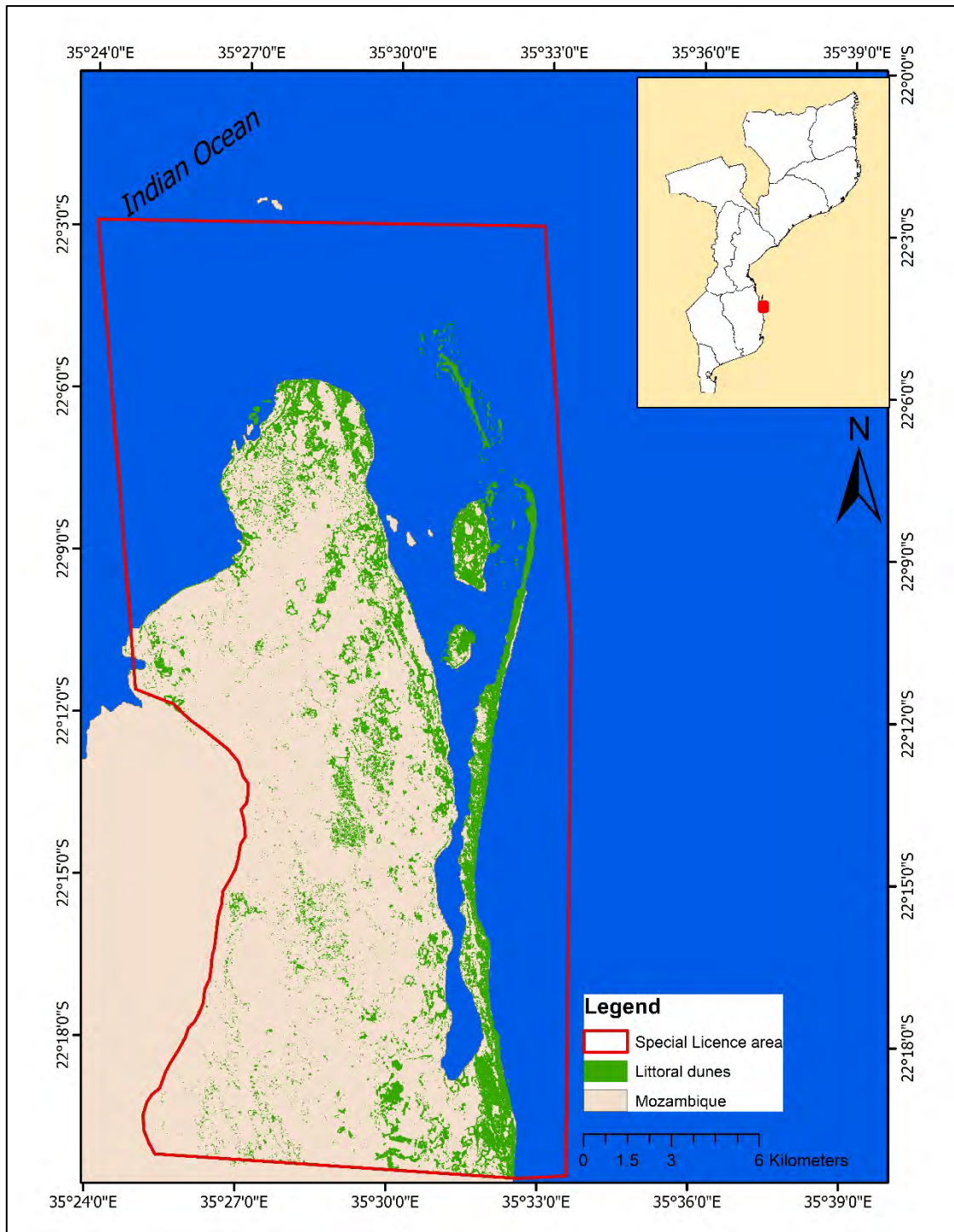


Figure 20: Preliminary map of the littoral dunes in VCWS

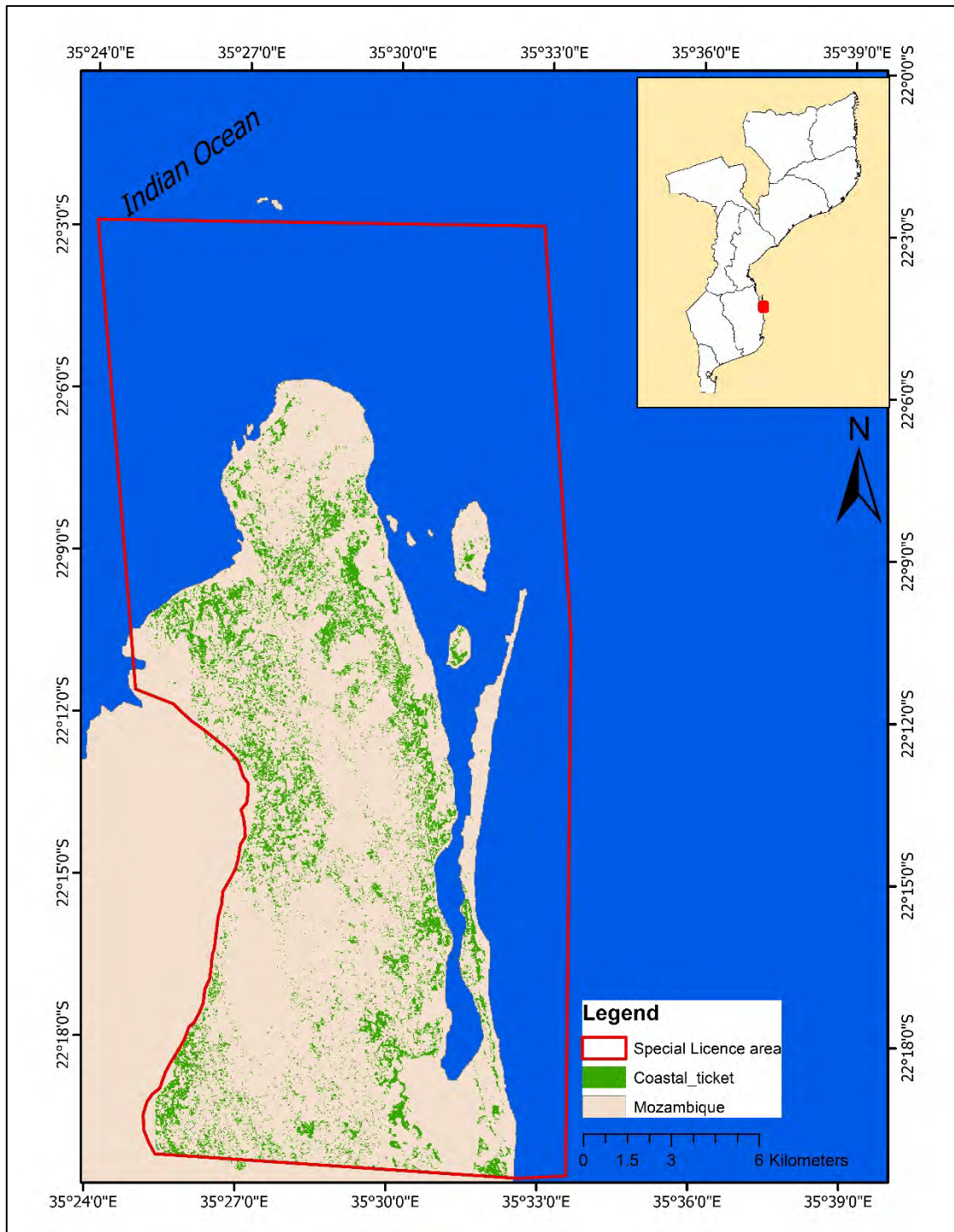


Figure 21: Preliminary map of the coastal thickets in VCWS

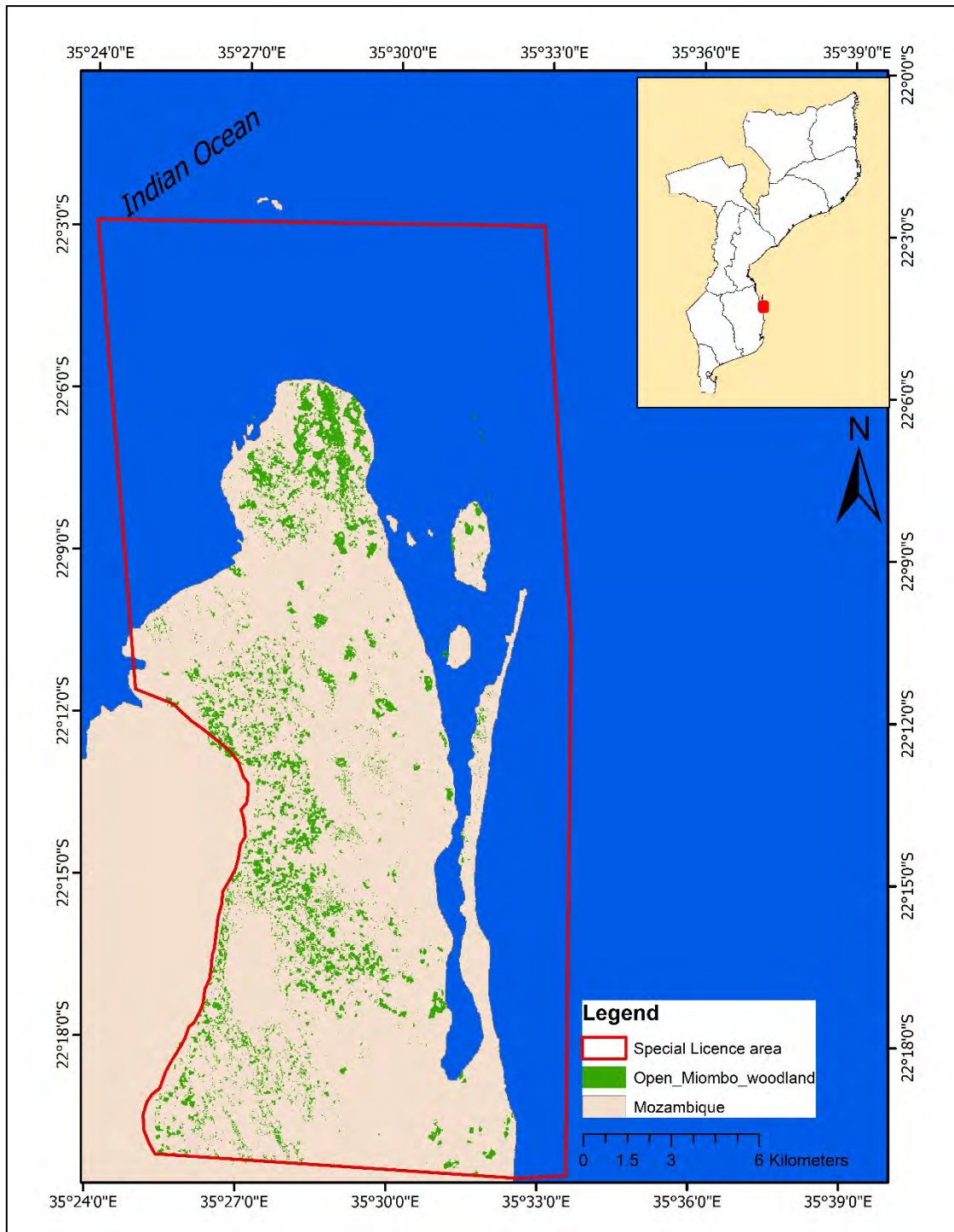


Figure 22: Preliminary map of the open miombo woodland in VCWS

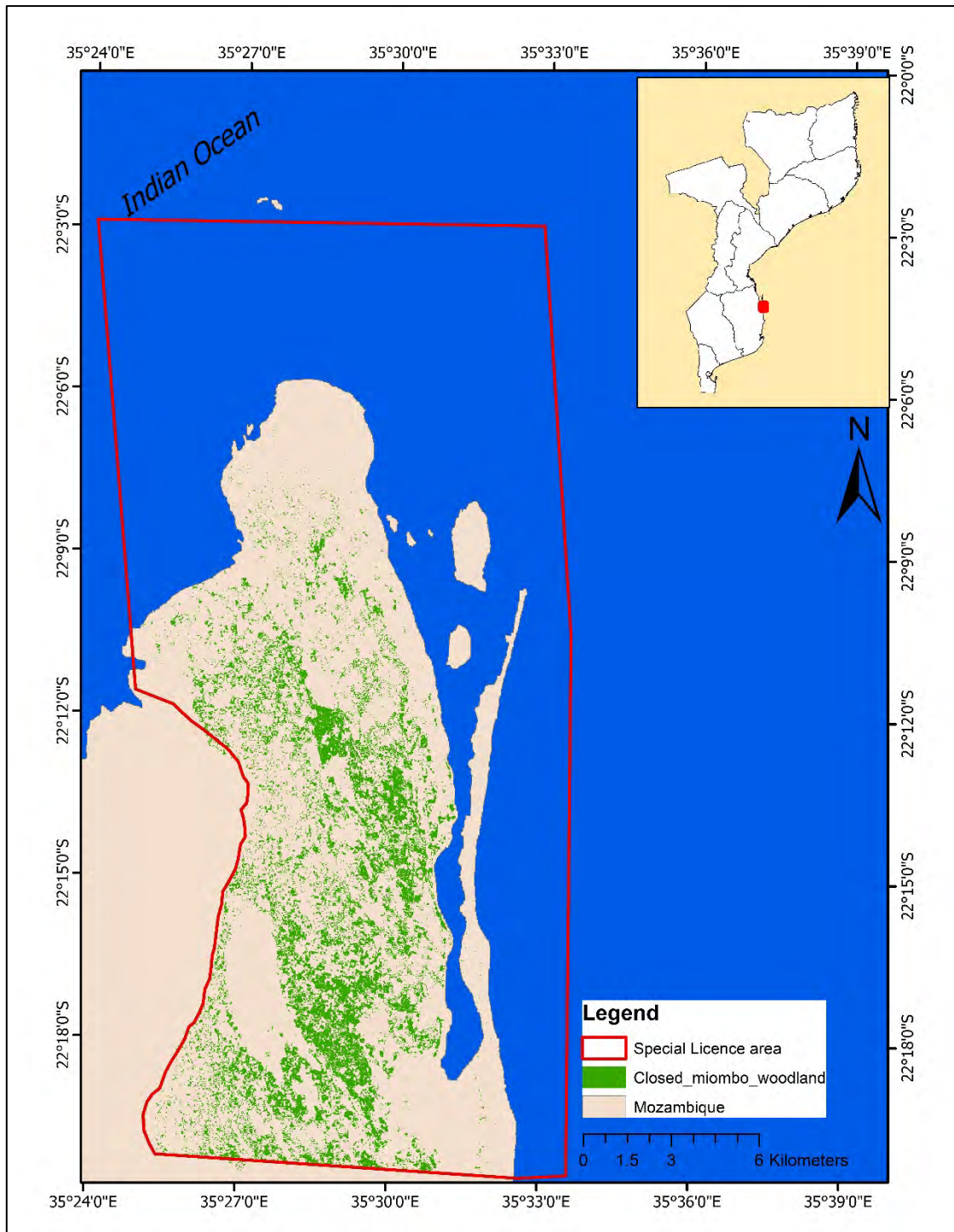


Figure 23: Preliminary map of the closed miombo woodland in VCWS

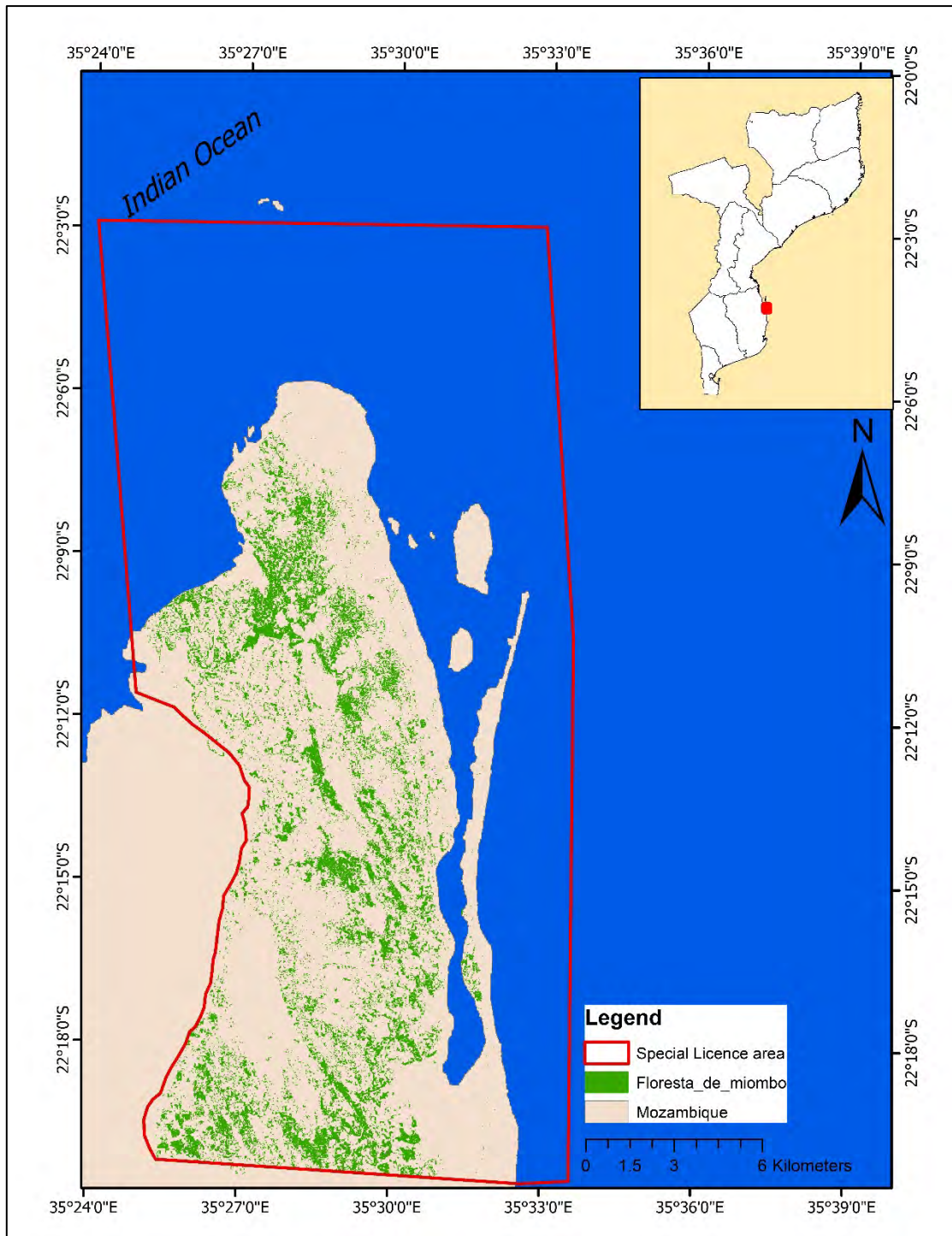


Figure 24: Preliminary map of the miombo forest in VCWS

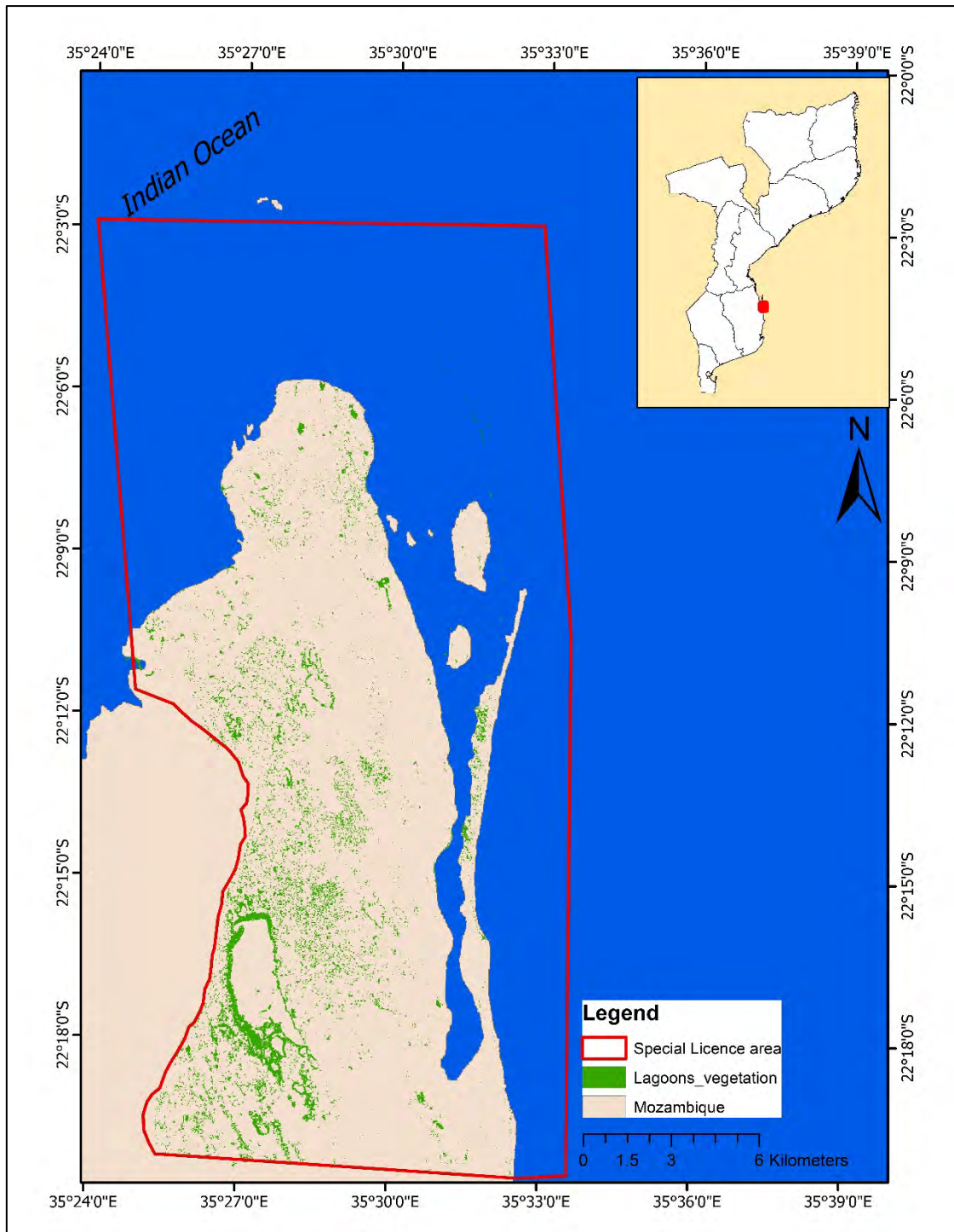


Figure 25: Preliminary map of the lagoons in VCWS

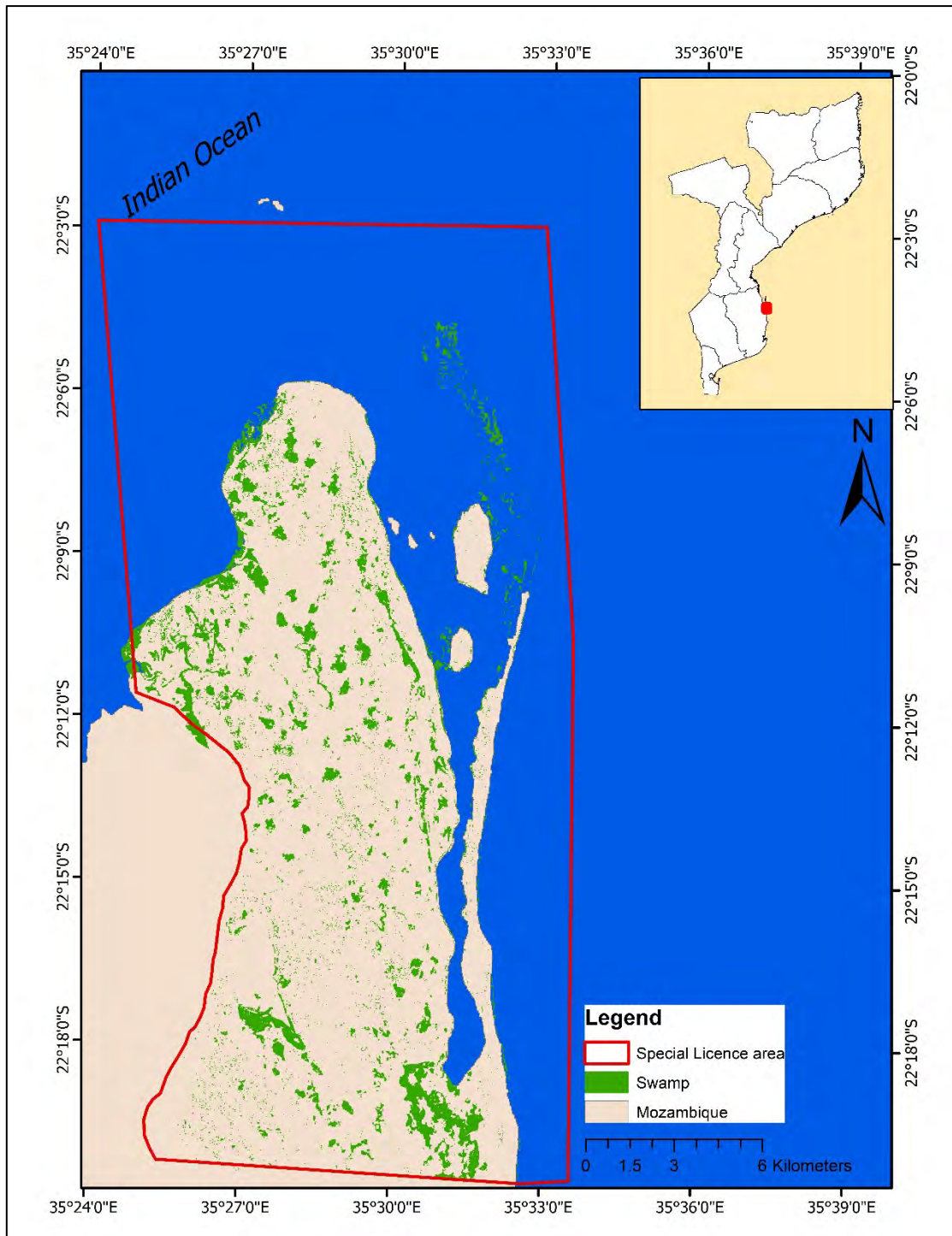


Figure 26: Preliminary map of the swamp in VCWS