CRITICAL ECOSYSTEM PARTNERSHIP FUND

CONSERVATION INTERNATIONAL

Update of the Ecosystem Profile for the Madagascar and the Indian Ocean Islands Biodiversity Hotspot

Report on priority ecosystem services

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& Experts

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Introduction

The Critical Ecosystem Partnership Fund (CEPF) first invested in Madagascar and the Indian Ocean Islands (IOI) Biodiversity Hotspot in 2001, with a five-year investment phase totalling $4.2 million that focused exclusively on the island of Madagascar. Since then, CEPF has awarded over US$18 million to Civil Society Organizations (CSOs) within the Madagascar and IOI Biodiversity Hotspot. In September 2012, the CEPF Donor Council selected the Madagascar and IOI Hotspot as a CEPF region eligible for ecosystem profiling and re-investment. In 2014, Conservation International Madagascar in collaboration with partners within Madagascar and the IOI developed an Ecosystem Profile for the Madagascar and IOI Hotspot. The Ecosystem Profile provides information regarding the current state of a biodiversity hotspot and the steps to protect its vulnerable biodiversity while simultaneously improving the livelihoods and well-being of local communities. It also outlines CEPF's investment strategy, which is framed by an analysis of the environmental, economic, and political context for conservation and restoration of critical ecosystems.

Conservation International (CI) in consortium with Biotope was appointed by the CEPF Secretary to update the 2014 Ecosystem Profile for Madagascar and the IOI Biodiversity Hotspot. This work is divided into three Work Packages (WP) as following:

- Work package 1 (WP1): Identification of important ecosystem services and areas for EbA;
- Work package 2 (WP2): Stakeholder consultations to set priorities for CEPF investment in EbA;
- Work package 3 (WP3): Drafting of an updated Ecosystem Profile.

This document corresponds to the deliverable called Draft report on priority ecosystem services within the Work Package 1.

1 Methodology

1.1 General approach

The approach of this study was conducted through three Work Packages. Under Work Package 1 (WP1), the KBA+ methodology was applied to rank the Key Biodiversity Areas (KBAs) in each country according to the importance of their contribution to the resilience of human populations to climate change. This required priority ecosystem services to be identified in each country and the relative importance of each KBA for each service to be evaluated, using semi-quantitative methods, employing a combination of data sources and expert opinion. This multi-criteria analysis allowed geographic priorities for CEPF investment in Ecosystem-based Adaptation to be established in each country.

Under Work Package 2 (WP2), consultations were held with stakeholders at sub-national, national and regional workshops to validate the assessment of priority ecosystem services, the weighting given to each service, and the relative importance assigned to each KBA, as well as to set thematic priorities for CEPF investment. Stakeholders participating in these workshops included representatives of government departments responsible for natural resources management and climate change, universities and other academic institutions, environmental NGOs and donor agencies.

Under Work Package 3 (WP3), the ecosystem profile for the Madagascar and IOI Biodiversity Hotspot was updated, incorporating the results of the KBA+ analysis and the stakeholder consultations.

1.2 Approach for Work Package 1

The general guidelines developed by CI, aimed at the coordination of teams representing the different countries involved, were used.

These guidelines include, firstly, the listing of ecosystem services, their description, the evaluation of data needed and sources to be consulted. The first step of the approach was to review the listing of KBA and their information, especially about the type of management and the entity administrating them. These entities were key partners during the consultation of stakeholders.

Secondly, a binary evaluation was made for each ecosystem service and each KBA, in order to select the main ecosystem services for the set of KBAs. Based on available data, studies and on expert knowledge, the ecosystem services were identified and assessed regarding their importance for the beneficiaries and the availability of data to quantify them.

Thirdly, a quantitative or semi-quantitative evaluation was done using the data sources selected in order to rank KBAs by importance for the various ecosystem services, individually and generally using a multicriteria approach. KBA matrix were filled in with the available data for each selected ecosystem service.

This analysis was subject to some alignment on the selected ecosystem services and data after consultation of experts and organisation of workshops with the stakeholders in the second phase of the project.

At the end, a multicriteria analysis was applied to the matrix in order to rank the KBA according to the importance of their contribution to the resilience of human populations to climate change and each priority ecosystem service was mapped spatially.

A summary of the approach to WP1 is given in Figure 1 below.

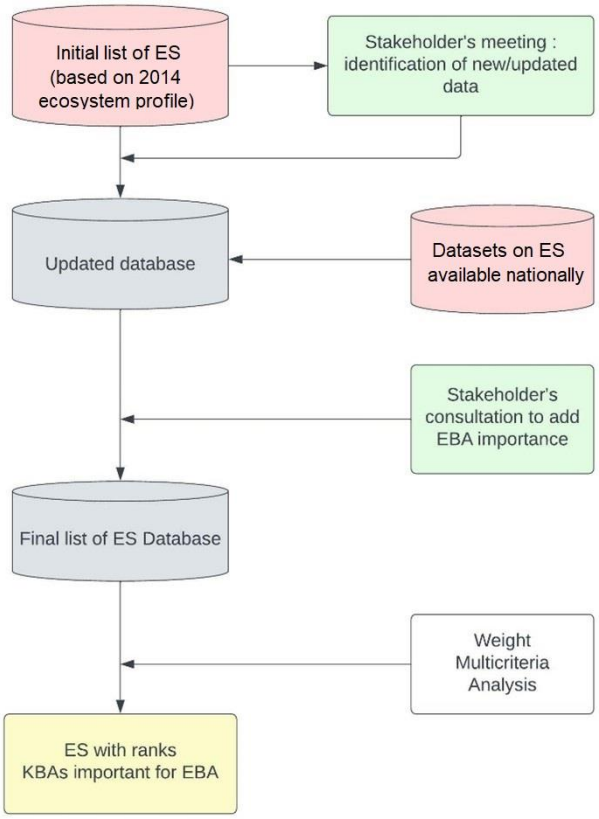


Figure 1 : Process flow of the approach to WP1

2 Comoros

The Union of the Comoros comprises 3 islands, the westernmost of the archipelago, located at the northern entrance to the Mozambique Channel, between Africa and Madagascar. From West to East, it is possible to distinguish Grande Comore (Ngazidja), Moheli (Mwali) and Anjouan (Ndzuani).

Demographics are increasing sharply, with an estimated population of over 750,000 inhabitants, which can reach a very high density in certain sectors of the archipelago (e.g. over 1,000 inhabitants/km²), which testifies to very strong anthropic pressure on the environment, highlighting one of the main threats to the ecosystems: deforestation. This is particularly aggravated by a rather young (high birth rate) and rural population (therefore requiring arable land). Access to education is limited, with compulsory schooling between the ages of 6 and 11. Threats and pressures are different in the cities, with difficulties in waste management and sanitation. Finally, water resources are also a major issue. The Union of the Comoros is one of the poorest countries, with an economic activity mainly focused on the exploitation of natural resources (agriculture, livestock, forestry, fishing), while commercial, tourism and industrial activities generate less employment and wealth.

2.1 Key Biodiversity Areas

In the 2014 CEPF Ecosystem Profile, a study was conducted in order to identify Key Biodiversity Areas in Comoros. 20 KBAs were identified, with only six strictly terrestrial ones, and 14 for coastal and marine areas. However, the number of sites and their biogeographical distribution clearly indicates an incomplete identification, and some smaller, lesser-known sites of biological importance would certainly be identified as KBAs should more field research and inventories be done.

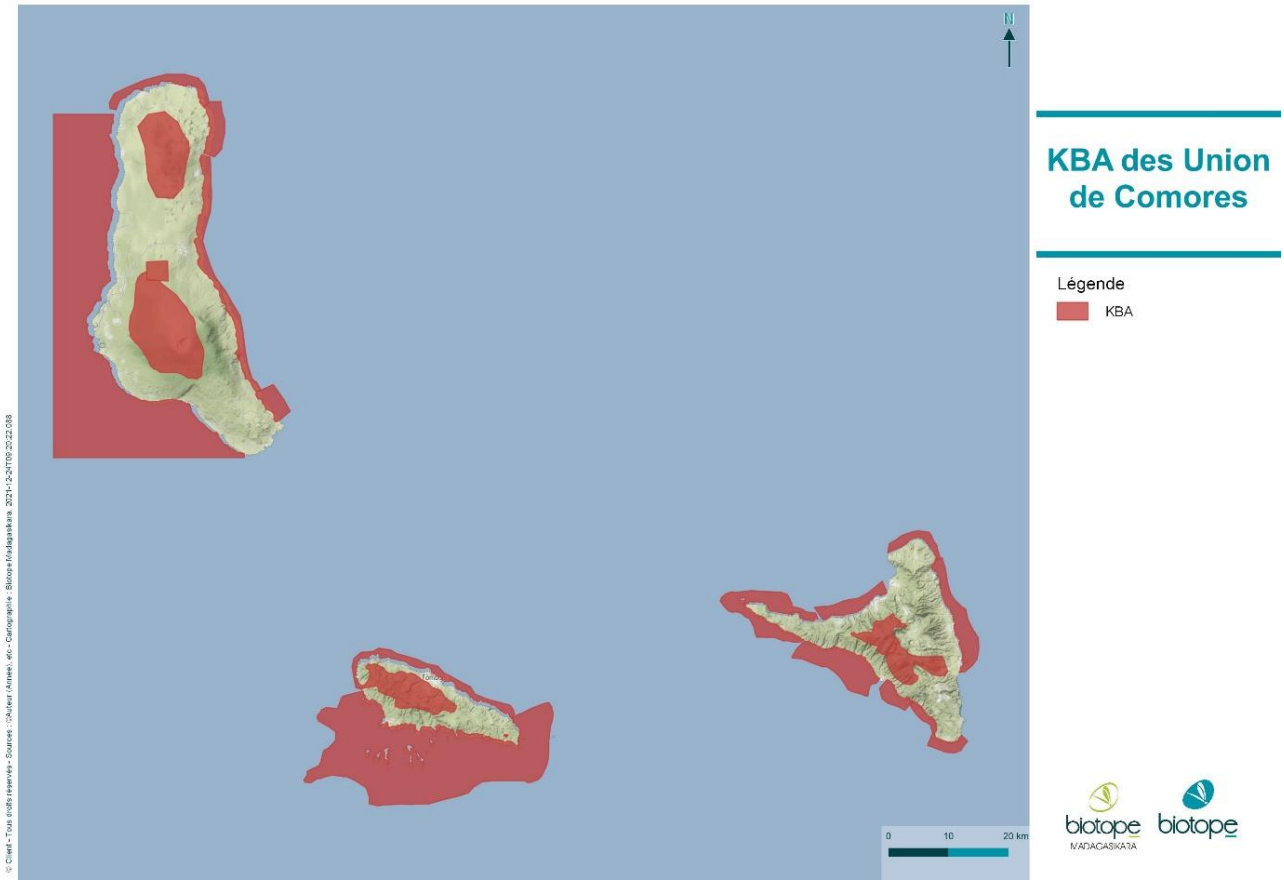
The Table 1 provides the complete list of KBAs and the map from Figure 2 identifies the KBAs.

Table 1: List of KBAs in Comoros Islands

KBA ID#	ZCB (nom Francais)	KBA (English name)
COM-1	Forêt de Moya	Moya Forest
COM-2	Lac Dziani-Boudouni	Dziani-Boudouni Lake
COM-3	Lac Hantsongoma	Hantsongoma Lake
COM-4	Massif de la Grille	La Grille Mountains
COM-5	Massif du Karthala	Karthala Mountains
COM-6	Mont Mlédjélé (Hauts de Mwali)	Mont Mlédjélé (Mwali highlands)
COM-7	Mont Ntringui (Hauts de Ndzuani)	Mont Ntringui (Ndzuani highlands)
COM-8	Parc Marin de Mohéli	Mohéli National Park
COM-9	Récifs coralliens d'Anjouan	Anjouan coral reefs
COM-10	Récifs coralliens de Grande Comore	Grande Comore coral reefs
COM-11	Récifs coralliens de Mohéli - hors Parc Marin	Mohéli coral reefs - outside of Marine Park
COM-12	Zone de Bimbini et Ilot de la Selle	Bimbini area and la Selle Islet

KBA ID#	ZCB (nom Francais)	KBA (English name)
COM-13	Zone de Chiroroni	Chiroroni area
COM-14	Zone de Domoni	Domoni area
COM-15	Zone de Male	Male area
COM-16	Zone de Moya	Moya area
COM-17	Zone de Mutsamudu	Mutsamudu area
COM-18	Zone de Ndroudé et Ilot aux Tortues	Ndroudé area and Ilot aux Tortues
COM-19	Zone de Pomoni	Pomoni area
COM-20	Zone du Coelacanthe	Coelacanthe area

Figure 2: Map of KBAs in Comoros Islands



Detailed maps of KBAs in Comoros are available in Appendix 1.

For this update, no modifications have been made regarding KBAs.

2.2 Ecosystem Services Identification

2.2.1 List of Ecosystem Services

This work is the product of a literature review and a public consultation using expert opinion. We consulted first KBA managers and experts who are directly involved in issues related to ecosystem services.

Assessments of ecosystem services, particularly in the Comoros archipelago, are relatively underdeveloped. Although the importance of ecosystem services is stated in various strategic development documents of the Union of the Comoros, they have not been sufficiently evaluated to provide quantitative data to assess the scientific, ecological and financial contributions to the benefit of local populations. However, the Comorian population is mostly rural and lives from agriculture and fishing, with 44.48% of the population living below the poverty line. The Comorian population benefits from the advantages of ecosystems in the areas of food, health care, energy and protection while striving to adapt to the major changes that these ecosystems are undergoing.

A list of 23 ecosystem services was initially established for Comoros through consultation with KBA managers and experts, as follows.

Table 2 : List of ecosystem services in Comoros

Division	Section	Group	Type of ES
Provisioning	Nutrition	Biomass	Commercial fisheries
			Gathering of wild fruits
			Gathering of medicinal plants
			Gathering spices (cinnamon bark)
		Water	Water for domestic use
	Materials	Biomass fiber	Wood for construction
			Wood for crafts
			Fodder for livestock
		Water	Water for irrigation
			Water for hydropower
	Energy	Thermal energy	Wood and charcoal
Regulation and maintenance	Mediation of waste, toxic substances and other nuisances	Mediation through ecosystem	Mangrove
	Climate regulation	Carbon stock	Forest
			Mangrove
	Disaster Risk Reduction	Flood protection	Forest
			Mangrove
			Reef
			Beach

Cultural	Physical and intellectual interactions with ecosystems and the land and seascape	Ecotourism	Forest
			Mangrove
			Reef
			Beach
		Cultural and spiritual value	Cultural sites

2.2.2 Selection of priority ecosystem services

From the list of ecosystem services in Table 2, a list of priority ecosystem services was selected, by a team of experts, by applying the following criteria:

- Contribution of the service to the resilience of local populations to climate change,
- Availability of data.

These criteria were applied based on a subjective assessment grounded in the knowledge of local experts, rather than through the application of objective indicators. Given the relative lack of information about the values of ecosystem services in the Comoros, the most important criterion was availability of data. After a draft list of priority ecosystem services had been prepared by the experts, it was presented at a series of stakeholder consultation workshops held in March 2022, where it was validated and weightings were given to each service, reflecting their relative importance for climate resilience.

The priority ecosystem services selected were (1) commercial fisheries, (2) water for domestic use, (3) water for irrigation, (4) water for hydropower, (5) wood for energy, (6) flood protection from mangroves, (7) flood protection from forests, (8) ecotourism and (9) cultural and spiritual values.

2.2.3 Standardization of ecosystem services

Different sources of data and formats were used to compile the data. Data normalization is necessary before being able to analyze them and to make meaningful comparison. Two normalizations were performed with the data; the former was used for the final analysis:

- Normalization by percentage or relative abundance: each of the data will be reclassified to evaluate their relative importance, and thus the parameter value would be divided by the maximum value. A value between 0 and 1 will be obtained,
- Normalization by presence/absence: each ecosystem services will be reclassified in binary form: 0 if it is absent, and 1 if it is present.

2.2.4 Importance according to Ecosystem-based Adaptation (EbA)

During the first aggregations, each ecosystem service was evaluated according to its presence/absence and or abundance relative to the KBAs. While this technique indicates the relative importance of ES, expert scoring was used to provide balance and highlight the most important ecosystem services for the EbA.

Table 3 : Ecosystem services scoring for multi-criteria analysis

Ecosystem Service	Weight
PROVISIONING	**0.55**
1. Commercial fisheries	0.20
2. Water for domestic use	0.15
3. Water for irrigation	0.10
4. Hydropower	0.05
5. Wood for energy	0.05
REGULATION & MAINTENANCE	**0.30**
6. Flood protection from mangroves	0.15
7. Flood protection from forest	0.15
CULTURAL	**0.15**
8. Ecotourism	0.10
9. Cultural and spiritual value	0.05
TOTAL	**1**

2.3 Priority Ecosystem Services

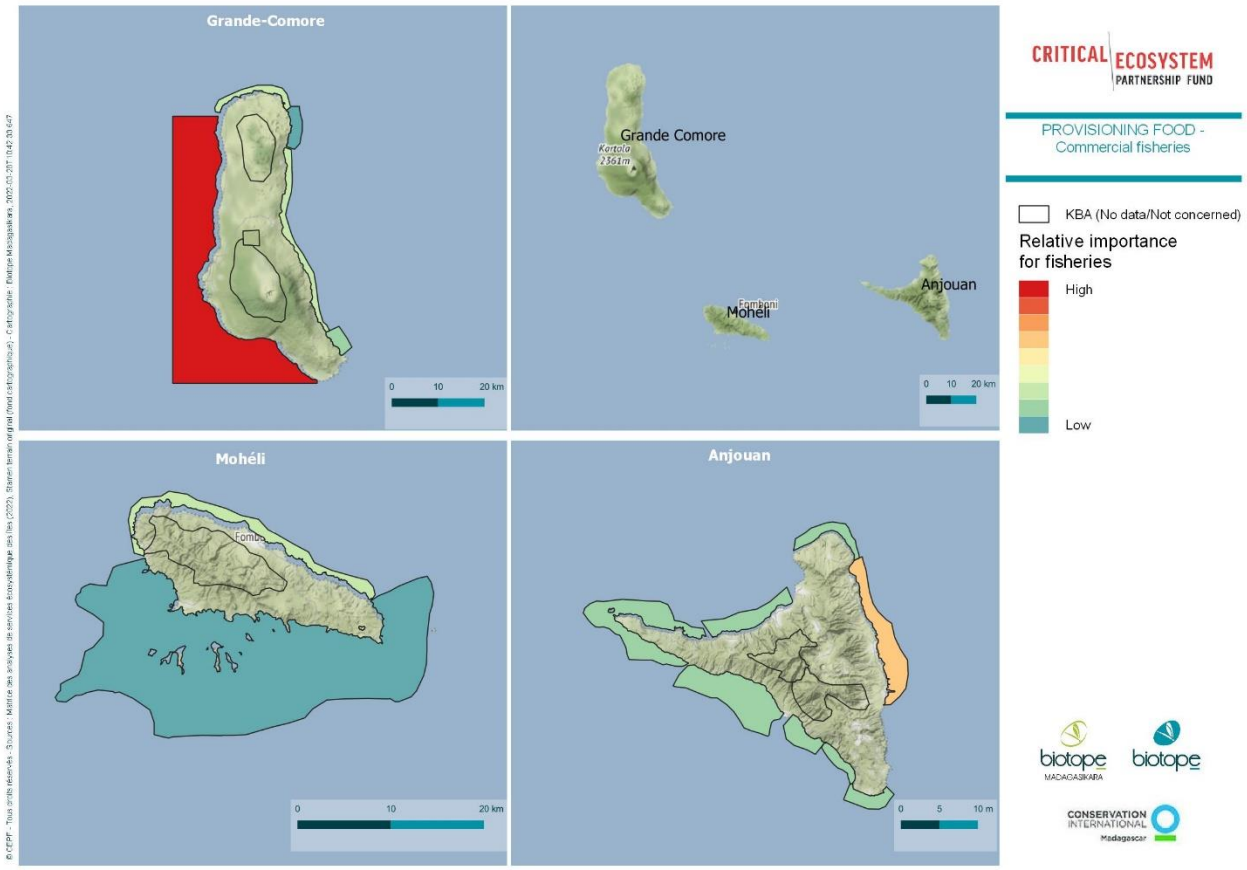
2.3.1 Provisioning: Commercial fisheries

The coastal or reef KBAs of the Comoros are fishing areas inhabited by a population of fishermen who live mainly from this resource. The 2020 fisheries statistics bulletin listed the landing ports and assessed the quantity of catches per port. This allowed us to assess the quantity of commercial fish caught in these KBAs in order to establish a geographical distribution of the quantity of fish caught per KBA.

In addition, the families of fishermen are the most vulnerable groups to the scarcity of sources. And women are the ones who sell fish in the market. During bad weather, the whole chain, from the fisherman, to the transporter and retailer, to the consumer, is heavily affected because the fishermen cannot go to sea. Indeed, fish is the main source of protein for Comorian families.

The 2021 statistical bulletin on fisheries, which is a synthesis of fisheries data in the Union of the Comoros, has again revealed that commercial fishing is a key sector for the economic development of the Comoros. For example, total landings from artisanal fisheries are estimated at 20,001 tonnes in 2020 with a total production value of 28,623,985,617 Comorian francs (equivalent to EUR 58 million in 2020 prices).

Figure 3 : Relative importance of KBAs in Comoros for commercial fisheries



2.3.2 Provisioning: Water for domestic use

Consisting of islands of volcanic origin, the four islands of the Comoros archipelago appeared at different geological times. The oldest islands, Mayotte, Moheli and Anjouan, have an important hydraulic network including permanent or semi-permanent rivers. On the other hand, Grande-Comore, the youngest island, does not have any rivers. Rainwater infiltrates under a very impermeable rocky soil to form underground water tables at the coastal level.

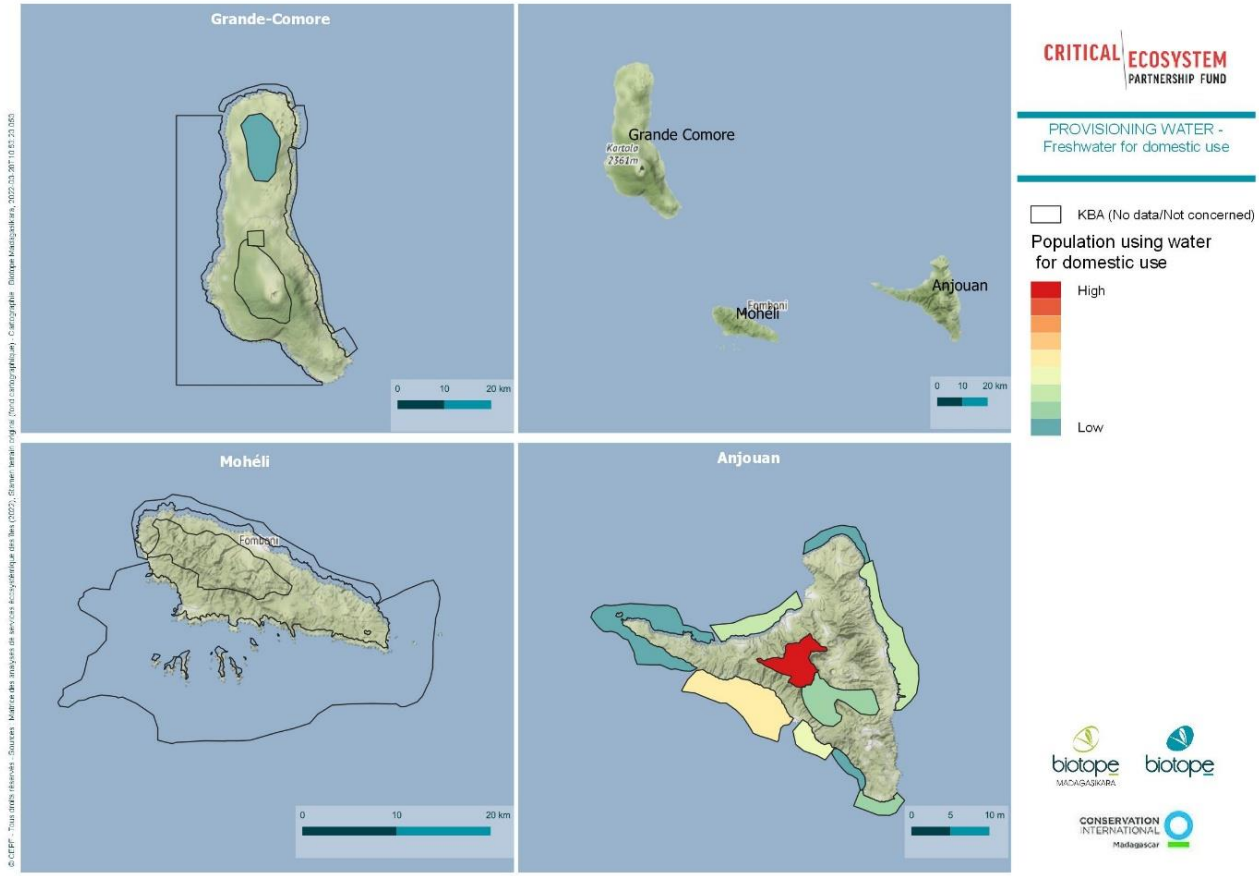
Thanks to the forest ecosystems sheltering the watercourses with an average rainfall of 800 mm but which can reach 6000 mm per year, the permanent or semi-permanent rivers make it possible to meet the daily water needs of the population of these two islands. Catchment basins for decantation and storage are built upstream to allow distribution to the houses through a piping system.

In Grande-Comores, at the KBA of La Grille Mountains, water gushes out from a natural spring with a flow rate of 3 to 4 m^3 per day in the dry season and 100m^3 in the rainy season. It is a precious source of water for the families of the village of the spring. The evaluation of this service will be based on the volume of water collected and the population that benefits from this service.

As part of the assessment of this ecosystem service in the relevant KBA, these water catchments and water sources were described, geolocated and mapped in order to:

- Assess the volume of water storage,
- Estimate the number of families connected to the water distribution network,
- Assess the volume and cost of water consumption of households connected to the *Société Nationale d'Exploitation et de Distribution des Eaux* (SONEDE) network.

Figure 4 : Relative importance of KBAs in Comoros for water for domestic use



2.3.3 Provisioning: Water for irrigation

The importance of the river network in Moheli and Anjouan has allowed the development of irrigation crops in these two islands. These irrigations are drawn directly from springs using rudimentary instruments, such as watering cans or buckets of water, by farmers who are located near a spring. In this case, it would be very difficult to estimate the amount of water used or the number of farmers using this process.

In other cases, water catchments are built with a piping system to bring water back to the fields away from a stream. We propose here to evaluate both the volume of water collected in the basin as well as the number of farmers connected to this irrigation water distribution system in the KBAs for the islands of Anjouan and Mohéli.

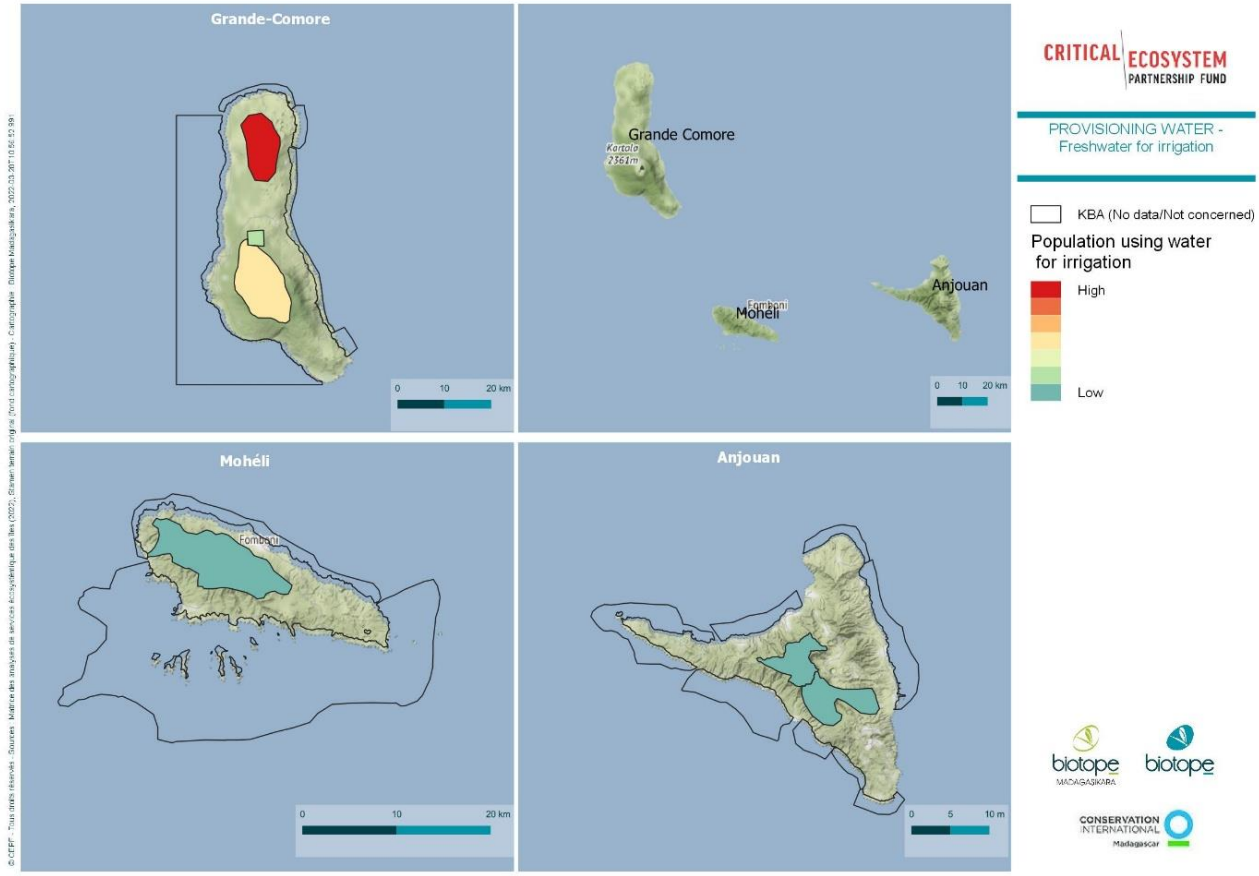
In Anjouan, the NGO Dahari has done a lot of work on the water courses in the catchment areas through mapping studies as well as on the flow of water from the catchment areas to the farmers' fields. Their mapping or water conveyance data will be of great interest to be integrated into this study.

On the island of Moheli, the Moheli Natural Park supports farmers to improve agricultural production in a sustainable way. During our direct interviews with experts from this organisation, we intend to collect all information related to irrigation. Similarly, bi- and multilateral cooperation projects are involved in watershed restoration and watercourse improvement. The coordinators of these projects would have relevant information about the watercourse and irrigation system. We expect to obtain this information to improve the quality of our work.

The island of Grande Comores does not have a permanent water course like Moheli and Anjouan. The farmers there practice a type of rain-fed agriculture. They are therefore trying to adapt to the current climatic challenges. Each of the three islands of the archipelago which is the subject of this study has a wetland associated with a lake ecosystem. These lakes, which are

smaller in terms of water volume, are fully protected and water drainage for irrigation is prohibited.

Figure 5 : Relative importance of KBAs in Comoros for water for irrigation

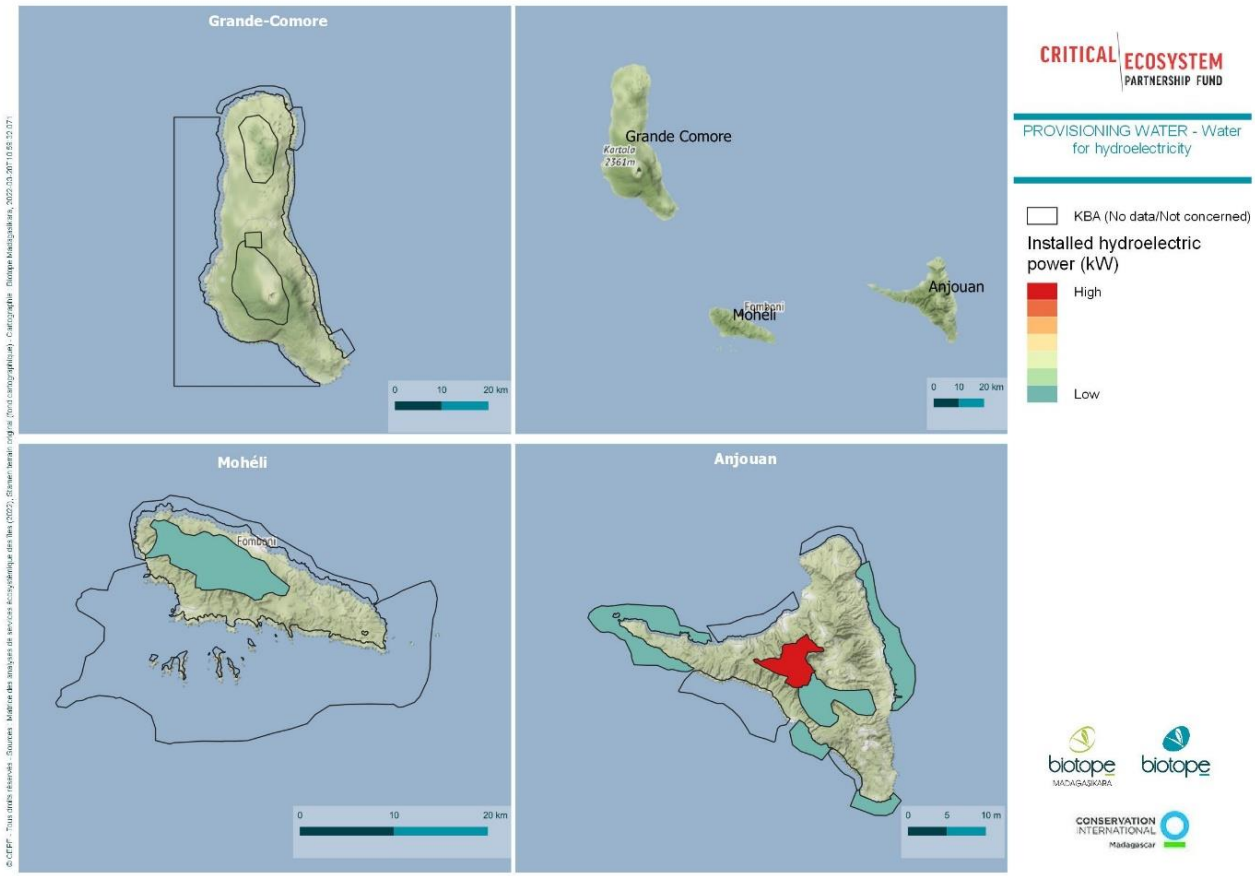


2.3.4 Provisioning: Water for hydropower

Hydropower is very little represented in the two islands concerned, Anjouan and Moheli, where there are permanent sources of water. These are hydroelectric dams, two of which are on Anjouan Island and one on Moheli Island.

The amount of energy in kilowatts supplied by each plant and the number of families connected to this system in the KBA concerned is used to determine this importance of this ecosystem service. In terms of available data, hydropower is the ecosystem service with the most available data, as the management of hydropower plants is ensured by the *Société Nationale d'Electricité des Comores*.

Figure 6 : Relative importance of KBAs in Comoros for water for hydropower



2.3.5 Provisioning: Wood for energy

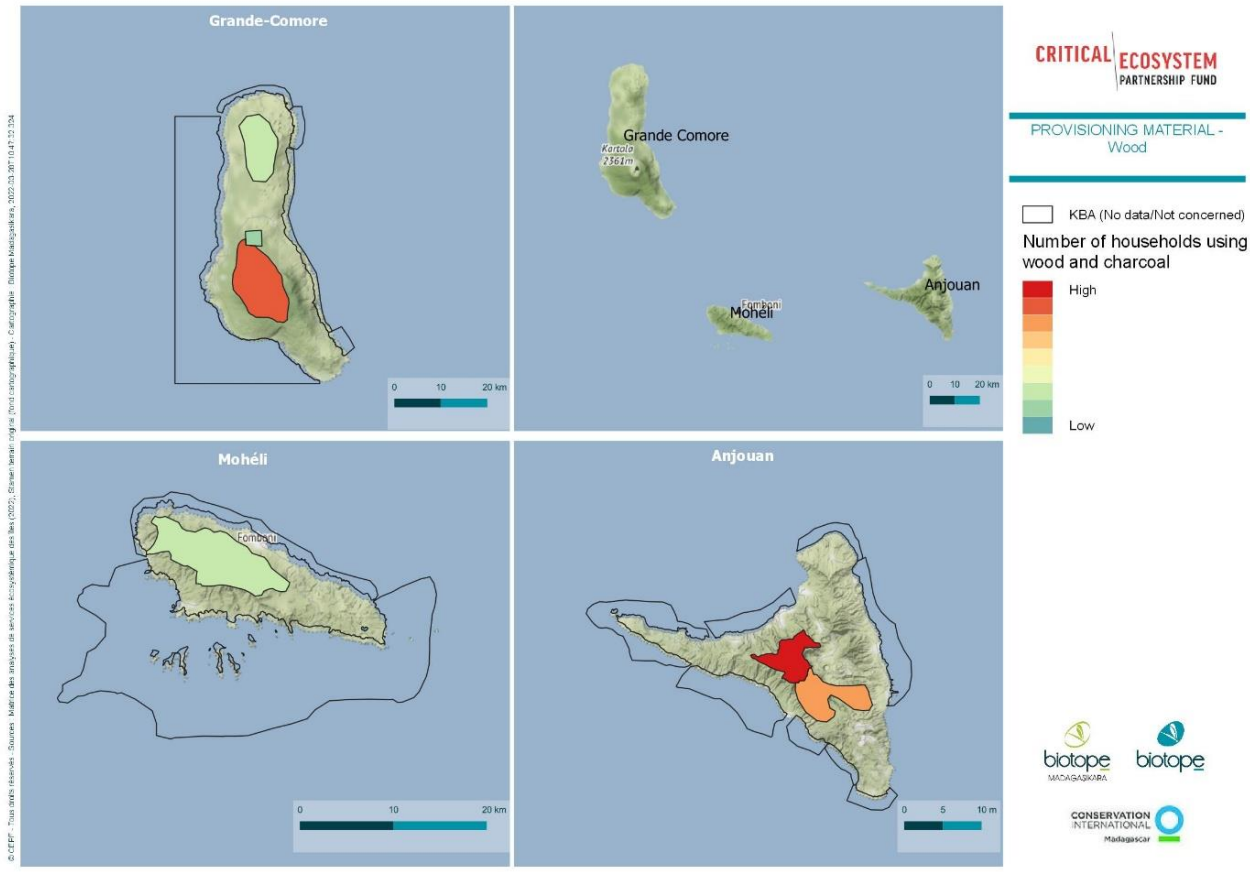
Wood is the main source of energy for Comorian families and the aromatic flower distillation industry. It consists of trees felled to make charcoal that will be sold in urban centres or of dry wood collected from the clearing of agricultural land. Both of these products are transported to the markets in towns and villages. It is a very profitable service that families have invested in promoting from production to marketing.

Although wood cutting seems to be limited in the low and medium altitudes, the strong demand for this energy resource is increasing. There is a gradual increase in the number of loggers in the secondary forests being reconstituted. The species most in demand by its abundance, quality and proximity is an invasive exotic species, *Psdyium cattelianum*. However, some native species of ecological interest are felled for the same purpose.

Data on wood consumption as a biomass supply are available. In fact, as part of the demographic campaign conducted by the *Institut National de la Statistique et des Etudes Economiques et Démographiques* (INSEED) in 2017, the number of households using different energy sources, including wood, gas and electricity for cooking, was recorded.

We extracted the number of families using wood and charcoal respectively for the forestry KBAs in order to assess the proportion of the population using this service.

Figure 7 : Relative importance of KBAs in Comoros for wood for energy



2.3.6 Regulation and maintenance: Flood protection from mangroves

During storms, mangroves play a decisive role in protecting riparian populations and nearby infrastructures against large waves, storm waves and tsunamis.

In terms of the ecosystem service of flood control, we preferred to stay with mangroves, as we had quantifiable information on the surface area and mapping as well as the population living in these areas. Despite the very limited surface area of the mangroves in the Comoros, a cartographic modelling of the populations and infrastructures located in the area can be carried out and the protected population evaluated.

2.3.7 Regulation and maintenance: Flood protection from mangroves

Terrestrial forests, especially watershed forests at high elevations, also provide an important regulating service by protecting downstream populations from flooding. Forests play this role by protecting soils that absorb water from rainfall and release it gradually into streams and rivers, thereby mitigating the risk of rapid run-off and catastrophic damage to property and life downstream. The relative importance of KBAs for this service was assessed based on the number of people living downstream from each KBA. Coastal and marine KBAs, not having downstream populations, were excluded from this analysis.

Figure 8 : Relative importance of KBAs for flood protection from mangroves

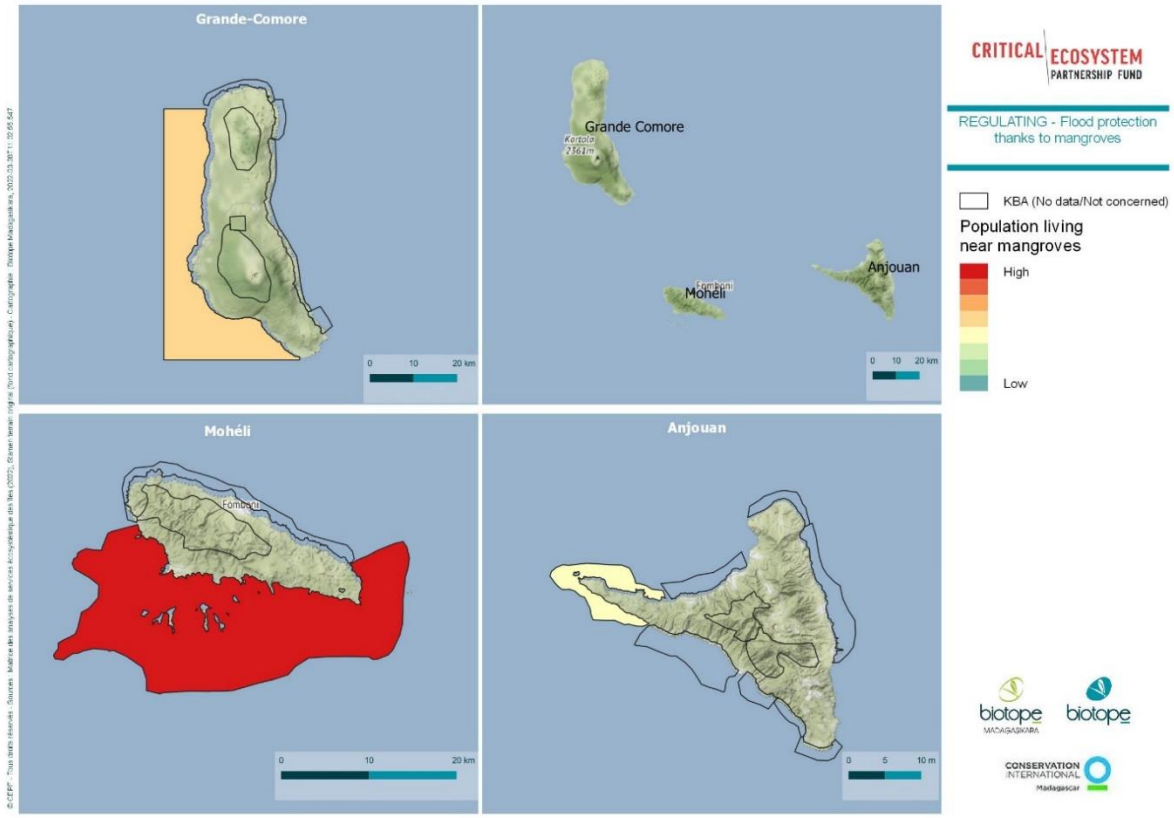
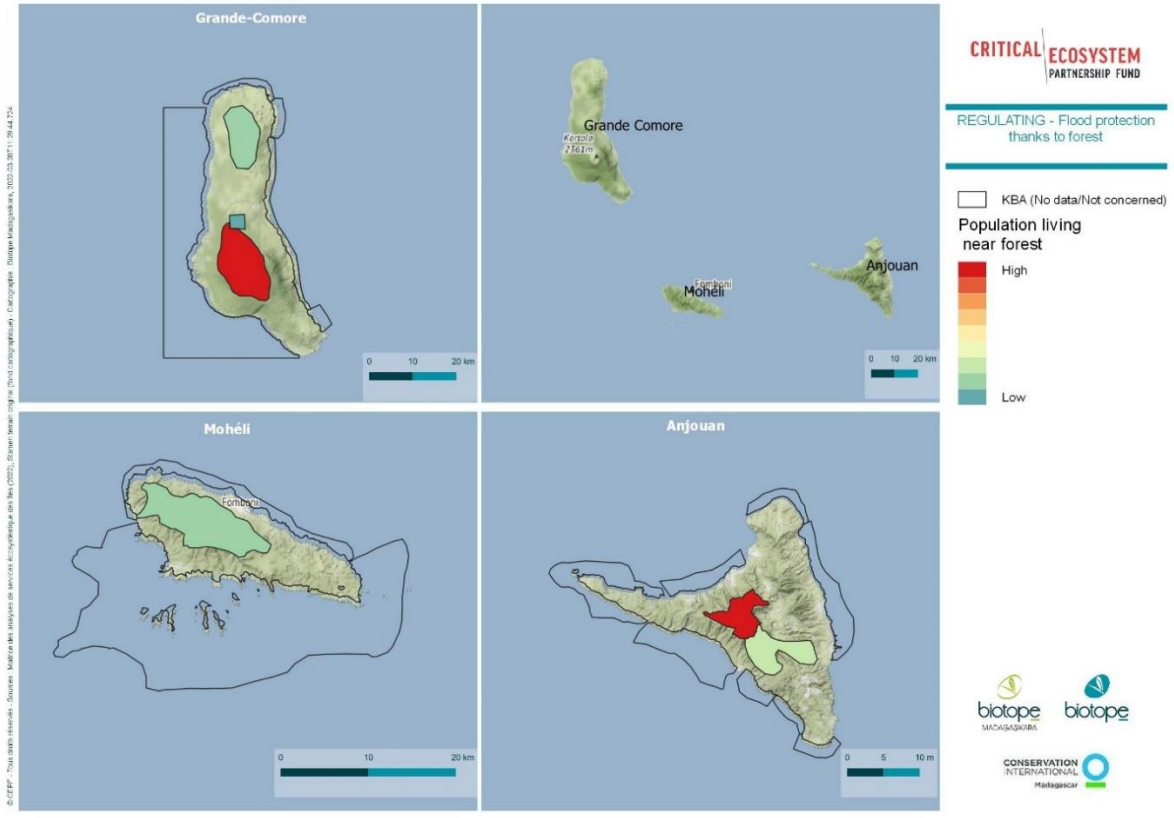


Figure 9 : Relative importance of KBAs for flood protection from forests



2.3.8 Cultural: Ecotourism

The Comoros is a country with an ecotourism vocation, despite the fact that the infrastructure for the promotion of ecotourism is either underdeveloped or non-existent. The very recent creation of the National Parks is still very promising for the development of this sector.

The National Directorate of Tourism and Hotels of Comoros (*Direction National du Tourisme et de l'hôtellerie*) admits that tourist visits to Comoros are of an ecological nature. Indeed, it is very easy to understand that due to the very small size of each island of the Comoros archipelago and the absence of luxury tourism infrastructures, tourists travelling to an island of the archipelago visit all the natural and cultural ecotourism sites of the island.

The latest *Annuaire Statistiques du Tourisme 2019-2020* of the Ministry of Economy, Investment and Energy, in charge of Economic Integration, Tourism and Handicrafts provides relevant data for the assessment of cultural services of each island of the Union of Comoros such as (i) tourism infrastructure: accommodation and restaurants, (ii) tourism sites: natural sites, archaeological sites; diving sites and (ii) tourism demand: international travellers' movements, overnight stays and hotel capacities.

However, for international movements, the data provided are global for all the islands of the Union of the Comoros, not data for each island.

Table 4 : List of accomodation in Grand-Comore (Source : *Annuaire statistiques du tourisme, 2019-2020*)

Nom de l'hôtel	Localité	Nbre de chambres	Nbre de lits	Téléphone / Email
Golden Tulip & Spa	Itsandra	68	136	Tel: 7733333 info@goldentulipgrandecomore-moroni.com
Le Retaj Hotel	Moroni	60	120	Tel: 773 52 78 / reservations.moroni@retaj.com b_karroo@retaj.com
Al Camar Lodge Luxury	Ndzaouze	30	60	3448131 / contact@alcamalodge.com
Moifaka Studio	Moroni	22	44	Tel : 773 03 33 / 7731556 / hmoifaka@yahoo.fr
Auberge Palace	Moroni	16	32	Tel : 773 88 43 / aubergepalace@gmail.com
Jardin De La Paix	Moroni	16	32	Tel : 773 28 00 / 3226213 info@comores-jardindelapaix.com jardin.paix@comorestelecom.km
La Grillade	Moroni	15	30	Tel : 773 2930/ 3253790 vacoalodge@gmail.com goulamkal@yahoo.fr
Les Arcades	Moroni	14	28	Tel : 773 28 47/ 3253720/ 3315051 hotel_les_arcades@hotmail.com
Motel Amis	Hahaya (Aéroport)	14	28	Tel: 336 51 29 motelami2015@gmail.com
Le Kalyptus	Moroni	12	24	Tel: 7731312 lekalyptus.moroni@gmail.com
Pesion Amal Hotel	Itsandra	8	16	Tel: 7733517 pensionamal@yahoo.fr
Youyou Hotel	Moroni	8	16	Tel : 3320356/ 3687211/ 4355615
Pension Zilimadjou	Moroni	7	14	Tel : 3333696
O 'chalet de l'Escale	Moroni	5	10	773 93 93 / o.chalets.lescale2021@gmail.com
Pension Faida	Moroni	5	10	Tel: 773 22 11 youssouf-mahmoud@yahoo.fr
Pension Le Gamboussi	Moroni	4	8	(+269) 325 00 82
Pension Iconi	Iconi	4	8	(+269) 3522896
Villa Jessica	Moroni	3	6	Tel: 7731602/ 7731366 / villajessica@yahoo.fr
TOTAL		311	622	

The data provided by the Annuaire Statistiques du Tourisme 2019-2020 breaks down the capacity of tourist accommodation in each island of the Union of the Comoros as follows:

Islands	Number of rooms	Number of beds	Proportion of the number fo beds (%)
Grande-Comore	311	622	0,41
Anjouan	331	622	0,41
Mohéli	135	270	0,18
Total		1514	1

Table 5 : Border arrivals of international visitors by country of residence. Source: Tourism Statistics Yearbook, 2019-2020

NATIONALITE	Janvier	Février	Mars	Avril	Mai	Juin	Juillet	Août	Septembre	Octobre	Novembre	Décembre	Total	%
Française	1353	1385	1419	1521	1661	3866	7824	3598	1716	1890	2396	4289	32918	73,03%
Britanique	17	46	37	39	59	68	137	112	85	75	116	151	942	2,09%
Allemande	5	15	10	9	12	10	25	19	16	19	4	16	160	0,35%
Belges	8	7	4	3	6	7	19	13	5	6	3	6	87	0,19%
Italie	6	9	7	5	4	9	15	12	9	18	4	3	101	0,22%
Autres Européennes	62	78	59	55	107	124	202	128	132	87	58	71	1163	2,58%
Malgache	254	193	229	224	121	134	368	204	113	251	203	175	2469	5,48%
Mauricienne	17	20	11	24	24	37	58	25	27	15	13	17	288	0,64%
Seychelloise	4	5	6	4	7	3	14	9	14	3	5	1	75	0,17%
Tanzanienne	57	70	59	64	58	56	139	54	53	65	47	48	770	1,71%
Kenya	11	12	15	12	8	31	68	26	19	75	27	35	339	0,75%
Sud africaine	13	21	10	14	12	17	27	13	15	11	14	17	184	0,41%
Egyptienne	3	5	3	7	9	5	20	6	23	19	9	46	155	0,34%
Autres Africaines et OI	71	142	161	88	108	206	355	252	146	121	137	133	1920	4,26%
Saoudienne	15	16	13	14	23	20	38	18	23	14	31	19	244	0,54%
Emirats Arabes Unis	5	12	6	17	11	14	21	24	16	18	21	32	197	0,44%
Autres Arabes	32	19	28	27	21	7	30	47	37	14	20	15	297	0,66%
Americaine (USA)	33	27	30	42	18	31	49	50	39	43	40	59	461	1,02%
Canadienne	10	19	12	8	5	11	26	14	17	7	12	10	151	0,33%
Autres americaines	21	17	18	18	22	18	60	29	28	12	40	28	311	0,69%
Chinoise	49	56	52	57	71	50	82	72	58	44	39	82	712	1,58%
Indienne	53	42	42	50	35	38	57	39	35	150	31	53	625	1,39%
Autres Asiatiques	17	14	30	15	20	37	36	82	42	66	18	24	401	0,89%
Océanique	3	6	11	7	12	6	15	10	7	5	13	12	107	0,24%
TOTAL	**2119**	**2236**	**2272**	**2324**	**2434**	**4805**	**9685**	**4856**	**2675**	**3028**	**3301**	**5342**	**45077**	**100%**

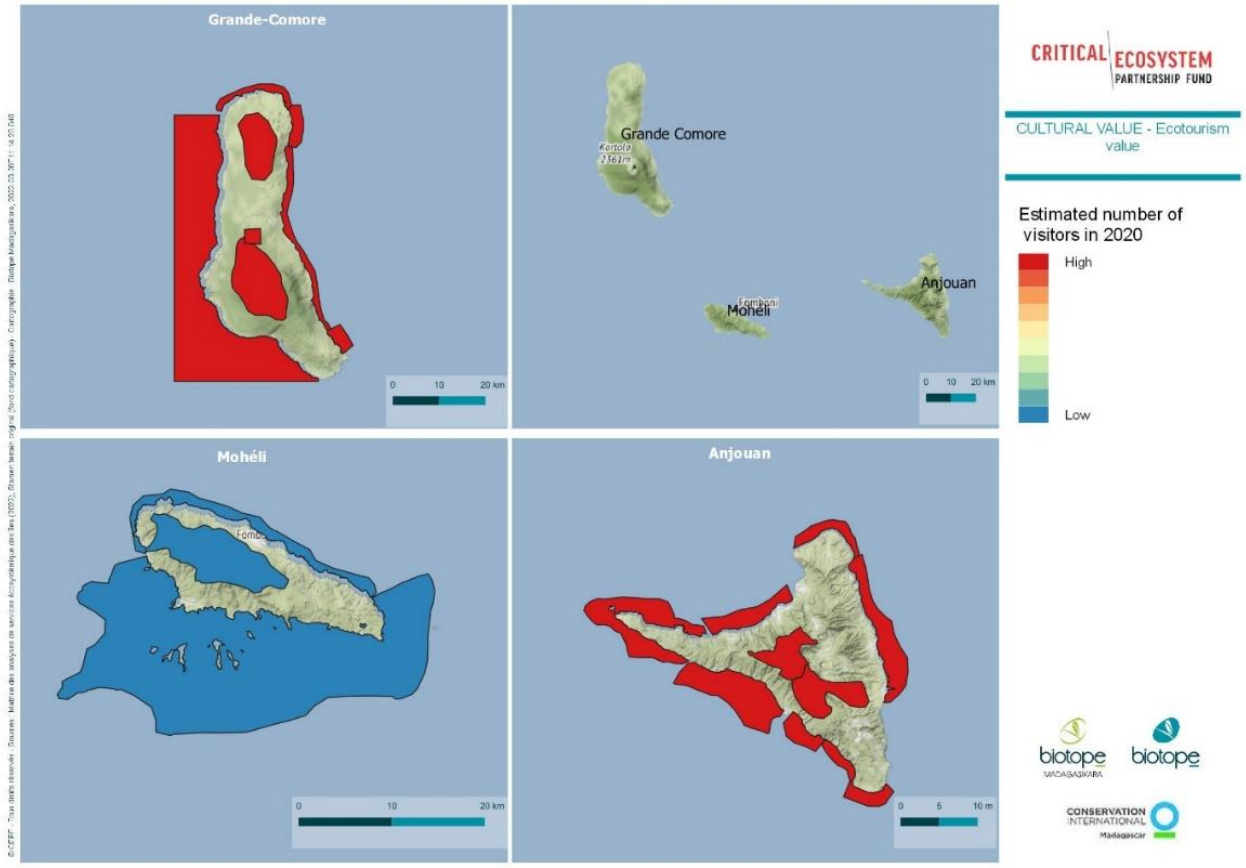
A total of 45,077 international tourists visited the Comoros for ecotourism in 2020.

Estimated number of international tourists visiting each island of the Union of the Comoros

Table 6 : Pondération des nombres de visiteurs écotouristique dans chaque île. (Source : *Annuaire statistiques du tourisme, 2019-2020)*

Island	Number of international tourists	Proportion
Grande-Comore	18 579	0,41
Anjouan	18 879	0,41
Mohéli	8039	0,18
Total	45 0077	1

Figure 10 : Relative importance of KBAs for ecotourism



2.3.9 Cultural: Cultural and spiritual

Some cultural sites and monuments of the Comoros are very positively appreciated by the scientific and local or international community. These are the medinas and royal palaces of the islands of Grande-Comores and Anjouan. These sites are already registered in the UNESCO World Heritage Tentative List. An ecotourism strategy for the cultural sites has just been developed. However, these sites are not included in any of the KBAs of Comoros to be considered in this study.

In addition to the KBAs, Comoros has natural sites of monumental and cultural interest such as lake ecosystems and mangroves that are places of spiritual pilgrimage. The forest massifs of Grande-Comores cover the remains of colonial residences of historical and cultural interest such as the Convalescence, the old industrial village of the former Boboni era, the industrial and

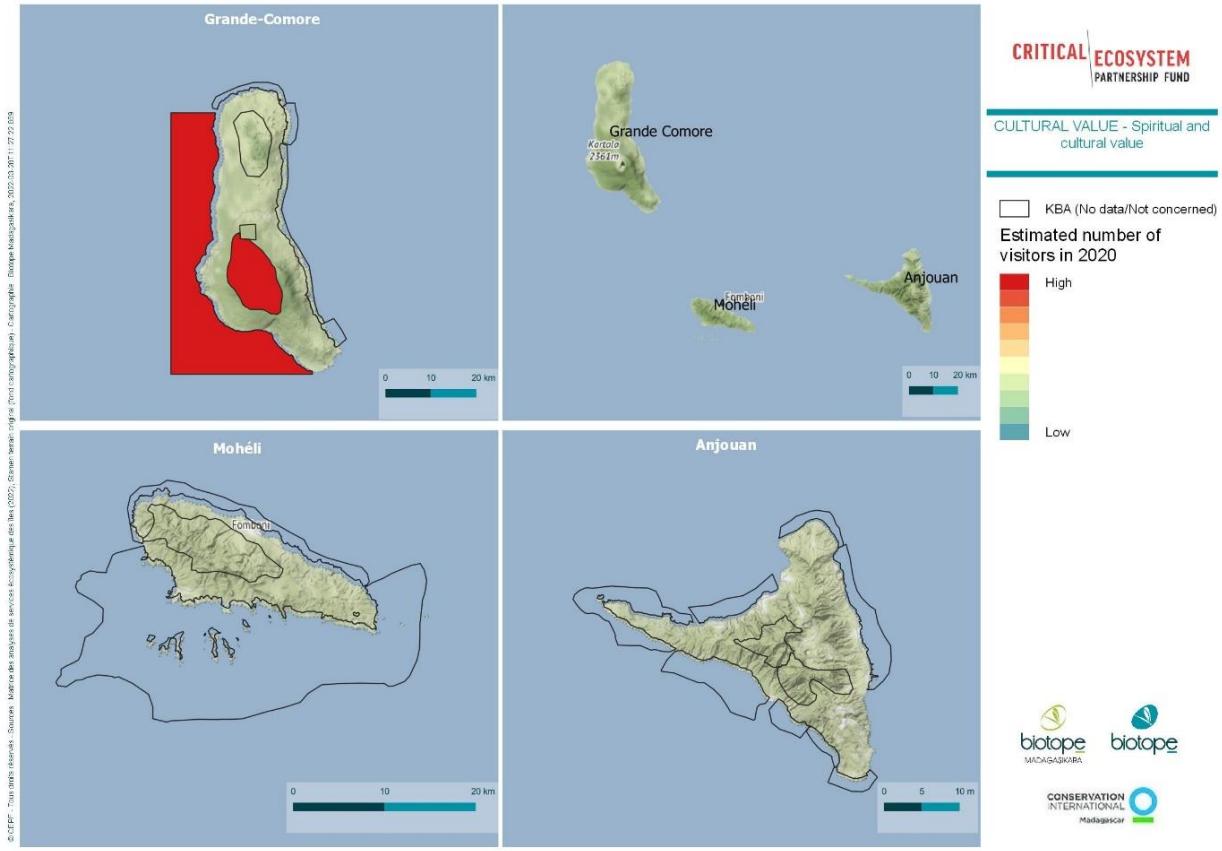
administrative site of the Nioumbadjou era for the Karthala and the House of Humblot at the Grille massif.

The estimation of the number of visitors was used to quantify the importance of KBAs for cultural and spiritual value.

Table 7 : Natural spiritual sites. (Source : Annuaire statistiques du tourisme, 2019-2020)

Grande Comore	Mohéli	Anjouan
Site du Karthala	Lac Boundouani	Mont N'tringui
Massif de la Grille – Côte Nord	Cascade de Wallah 2	Plateau de Hombo
Plateau de Diboini	Chalet Saint Antoine	Foret des petits ducs – Moya
Forêt de Maoueni	Site des Makis - Djoiezi	Lac Dzialandze - Dindr
Sites des cavernes - Dzoidjou	Sites de Livingstoni - Wallah 1	
Site de Nyumbadjou - Djoumoichongo		
Site de Bahani (Lac Hantsogoama /Grotte du Capitaine Du-Bois		

Figure 11 : Relative importance of KBAs for cultural and spiritual value



2.3.10 Multicriteria analysis: Ranking of KBAs

After aggregation of all the data and calculation of the multicriteria analysis, we obtain the classification of the KBAs as presented in the table below.

Table 8 : Results from the methodology KBA+ for Comoros

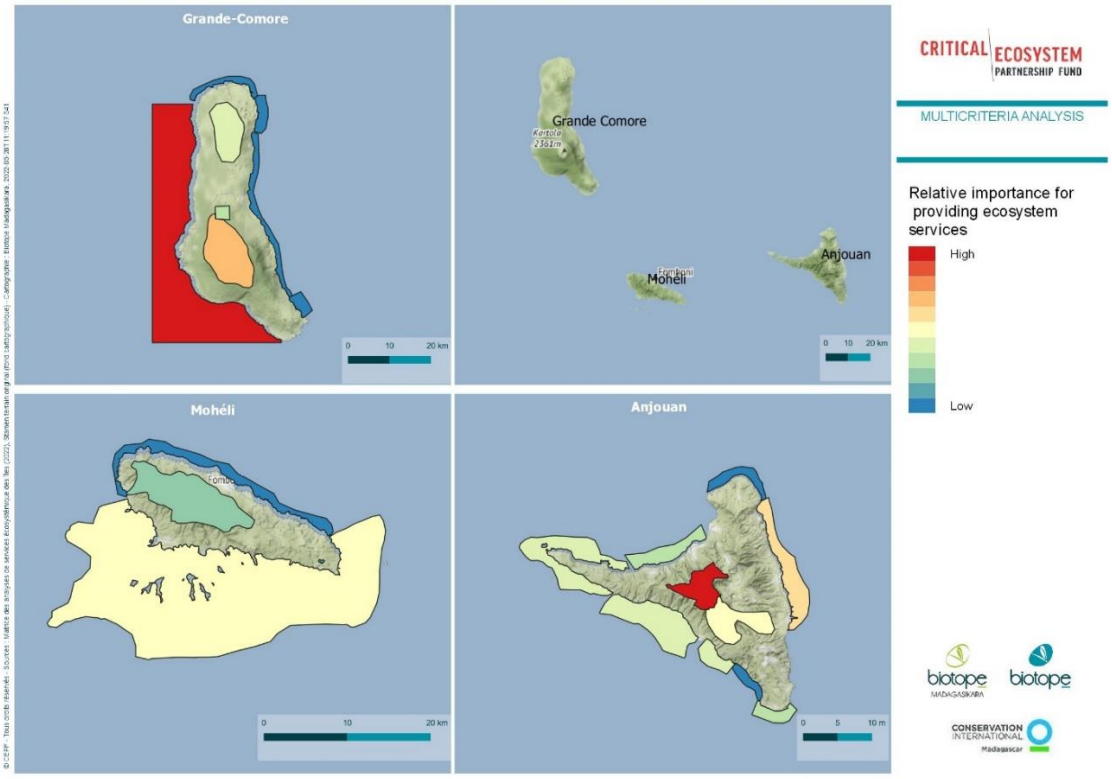
KBA Name	PROVISIONING										REGULATION & MAINTENANCE				CULTURAL				Multi criteria analysis - Total	Rank
	Commercial fisheries		Wood for energy		Water for domestic use		Water for irrigation		Water for hydropower		Flood protection from mangroves		Flood protection from forest		Ecotourism		Cultural and spiritual			
	Yes/ No (0/1)	Mass of landed fish (kg)	Yes/ No (0/1)	No of families using charcoal	Yes/ No (0/1)	People using water	Yes/ No (0/1)	No. of farmers using water	Yes/ No (0/1)	Installed capacity (kW)	Yes/ No (0/1)	Protected population	Yes/ No (0/1)	Protected population	Yes/ No (0/1)	No of visitors	Yes/No (0/1)	No of visitors		
Mont Ntringui (Hauts de Ndzuani)	0	0	1	4096	1	25771	0	0	1	585	0	0	1	46979	1	18 519	0	0	0.54	1
Massif du Karthala	0	0	1	3408	0	0	1	189	0	0	0	0	1	51957	1	18 519	1	18 519	0.45	2
Zone du Coelacanthe	1	3304	0	0	0	0	0	0	0	0	1	2 382	0	0	1	18 519	1	18 519	0.43	3
Forêt de Moya	0	0	1	2914	1	4947	0	0	0	0	0	0	1	15702	1	18 519	0	0	0.27	4
Zone de Domoni	1	1939	0	0	1	7282	0	0	0	0	0	0	0	0	1	18 519	0	0	0.25	5
Massif de la Grille	0	0	1	932	1	1280	1	347	0	0	0	0	1	10449	1	18 519	0	0	0.22	6
Ex Parc Marin de Mohéli	1	257	0	0	0	0	0	0	0	0	1	4710	0	0	1	8 039	0	0	0.21	7
Zone de Bimbini et Ilot de la Selle	1	544	0	0	0	0	0	0	0	0	1	1 812	0	0	1	18 519	0	0	0.19	8
Zone de Pomoni	1	590	0	0	1	11702	0	0	0	0	0	0	0	0	1	18 519	0	0	0.18	9
Zone de Moya	1	558	0	0	1	8986	0	0	0	0	0	0	0	0	1	18 519	0	0	0.17	10
Récifs coralliens de Grande Comore	1	915	0	0	0	0	0	0	0	0	0	0	0	0	1	18 519	0	0	0.16	11
Zone de Mutsamudu	1	534	0	0	1	5773	0	0	0	0	0	0	0	0	1	18 519	0	0	0.15	12
Lac Hantsongoma	0	0	1	409	0	0	1	68	0	0	0	0	1	3659	1	18 519	0	0	0.14	13
Récifs coralliens d'Anjouan	1	509	0	0	0	1082	0	0	0	0	0	0	0	0	1	18 519	0	0	0.14	14
Zone de Chiroroni	1	290	0	0	1	2920	0	0	0	0	0	0	0	0	1	18 519	0	0	0.13	15
Zone de Male	1	295	0	0	0	0	0	0	0	0	0	0	0	0	1	18 519	0	0	0.12	16
Mt Mlédjélé (Hauts de Mwali)	0	0	1	1056	0	0	0	0	1	17	0	0	1	9760	1	8 039	0	0	0.11	17
Zone de Ndroudé et Ilot aux Tortues	1	68	0	0	0	0	0	0	0	0	0	0	0	0	1	18 519	0	0	0.10	18
Récifs coralliens de Mohéli - hors Parc Marin	1	711	0	0	0	0	0	0	0	0	0	0	0	0	1	8 039	0	0	0.09	19
Lac Dziani-Boudouni	0	0	1	203	0	0	0	0	0	0	0	0	0	0	1	8 039	0	0	0.05	20

The final ranking is presented in Table 9 and Figure 12 below.

Table 9 : KBAs ranked by multi-criteria analysis

Code	KBA	Multicriteria score
COM-7	Mont Ntringui (Hauts de Ndzuani)	0.54
COM-5	Massif du Karthala	0.45
COM-20	Zone du Coelacanthe	0.43
COM-1	Forêt de Mova	0.27
COM-14	Zone de Domoni	0.25
COM-4	Massif de la Grille	0.22
COM-8	Ex Parc Marin de Mohéli	0.21
COM-12	Zone de Bimbini et Ilot de la Selle	0.19
COM-19	Zone de Pomoni	0.18
COM-16	Zone de Mova	0.17
COM-10	Récifs coralliens de Grande Comore	0.16
COM-17	Zone de Mutsamudu	0.15
COM-3	Lac Hantsongoma	0.14
COM-9	Récifs coralliens d'Aniouan	0.14
COM-13	Zone de Chiroroni	0.13
COM-15	Zone de Male	0.12
COM-6	Mont Mlédiélé (Hauts de Mwali)	0.11
COM-18	Zone de Ndroudé et Ilot aux Tortues	0.10
COM-11	Récifs coralliens de Mohéli - hors Parc Marin	0.09
COM-2	Lac Dziani-Boudouni	0.05

Figure 12 : Relative importance of KBAs for providing multiple ecosystem services



3 Mauritius

Mauritius is classified as High Middle Income Developing Country. Much progress has been made in reducing absolute poverty, and efforts are on-going. In essence, whilst there are some pockets of poverty, very few people are homeless or cannot afford two- or three-square meals per day. The dependence of people in general to biodiversity, even from the poorer classes, is weak. Also, where these pockets of extreme poverty may be found, if applying the 10 km criteria, these communities will be close to one, if not several, KBAs. The criterion is thus inapplicable to the Republic of Mauritius or has to be reviewed.

Due to rapid development, the loss of habitat and decline of biodiversity is equally rapid, with a long list of plants and animals red-listed.

Mauritius and Rodrigues being small islands (60x40 km and 18 by 8 km respectively), they are considered as part of a maritime state. The sea is within 10 km reach for most of Mauritius, and all of Rodrigues. Again, the criterion cannot be applied or needs amendment.

3.1 Key Biodiversity Areas

In the 2014 CEPF Ecosystem Profile, a study was conducted in order to identify Key Biodiversity Areas in Mauritius. KBAs were determined first on the basis of identified IBAs (BirdLife, 2001) and by joining adjacent similar and complementary sites of highly threatened biodiversity instead of dividing into smaller biological areas. In many cases, Conservation Management Areas (CMAs) or other legally protected sites are usually better surveyed than adjacent areas, while species are often found in surrounding areas. For instance, important mountains endemic could be found in areas close to the Mount Cocotte area, outside of the Black River Gorges National Park. Therefore, KBAs were defined as including not only the site already under formal protection, but also the adjacent buffers deemed critical for the survival of species occurring in the area. This approach led to the identification of 17 KBAs: one in Saint Brandon, three in Rodrigues and thirteen in Mauritius. Due to the high level of endemism and the rarity of many species, it is certain that some other, smaller sites could have qualified as KBAs on the sole criteria of presence of endangered species. The study does not deny the importance of these sites, but the choice was made to consider a smaller set of larger areas, which host the largest part of the endangered Mauritian biodiversity.

The Table 2 provides the complete list of KBAs and the map from Figure 3 identifies the KBAs.

Table 10: List of KBAs in Mauritius

KBA ID#	ZCB (nom Francais)	KBA (English name)
MUS-1	Bancs de Cargados Carajos	Cargados Carajos Shoals
MUS-2	Chaine des Monts Bambou	Bambou Mountain Range
MUS-3	Chamarel - Le Morne	Chamarel - Le Morne
MUS-4	Chutes Tamarin / Mont Simonet / Reserve Naturelle du Cabinet	Tamarind Falls / Mount Simonet / Cabinet Nature Reserve
MUS-5	Forêts reliques du Plateau central	Relict Forests of the Central Plateau
MUS-6	Ilots de Rodrigues	Rodrigues' Islets
MUS-7	Illots du Nord de l'ile Maurice	Mauritius Northern Islets
MUS-8	Ilots du Sud-Est de l'Ile Maurice	Mauritius South-Eastern Islets
MUS-9	Le Pouce - Anse Courtois - Pieter Both - Montagne Longue	Le Pouce - Anse Courtois - Pieter Both - Longue Mountain

KBA ID#	ZCB (nom Francais)	KBA (English name)
MUS-10	Mondrain - Magenta - Trois Mamelles - Mont du Rempart	Mondrain - Magenta - Trois Mamelles - Mont du Rempart
MUS-11	Montagne Corps de Garde	Corps de Garde Mountain
MUS-12	Parc National des Gorges de la Riviere Noire et zones adjacentes	Black River Gorges National Park and surrounding areas
MUS-13	Plaine Corail	Plaine Corail
MUS-14	Plaine des Roches - Bras d'Eau	Plaine des Roches - Bras d'Eau
MUS-15	Pont Bon Dieu	Pont Bon Dieu
MUS-16	Versant Sud de Grande Montagne	South Slopes of Grande Montagne
MUS-17	Yemen-Takamaka	Yemen-Takamaka

Figure 13: Map of KBAs in Mauritius

Detailed maps of the KBAs in Mauritius are available in Appendix 2.

For this update, no modifications have been made regarding KBAs.

3.2 Ecosystem Services Identification

3.2.1 List of Ecosystem Services

This work is the product of a literature review and a public consultation using an expert opinion approach. We consulted first KBA managers and experts who are directly involved in issues related to ecosystem services.

Based on these consultations and literature review, a list of 12 ecosystem services was initially established for Mauritius, as follow.

Table 11 : List of ecosystem services in Mauritius

Division	Section	Groupe	Type de SE
Provisioning	Nutrition	Biomass	Edible plants / fruits
			Commercial fisheries
		Water	Water for domestic use
	Materials	Water	Water for irrigation
	Energy	Mechanical energy	Water for hydropower
Regulation and maintenance	Mediation of waste, toxic substances and other nuisances	Mediation through ecosystems	Regulation of water quality for household use, irrigation and hydropower
	Flow mediation	Mass flow	Reducing soil erosion
		Protection against extreme weather events	Flood protection
			Cyclone protection
	Maintenance of physical, chemical and biological conditions	Life cycle maintenance, habitat and gene pool protection	Sustaining habitats and genetic diversity
		Regulation of atmospheric composition and climate	Sustaining atmospheric composition and climate
Cultural	Physical and intellectual interactions with ecosystems and the land and seascape	Physical and experiential interactions	Ecotourism
		Intellectual and representational interactions	Cultural value

3.2.2 Selection of priority ecosystem services

From the list of ecosystem services in Table 11, a list of priority ecosystem services was selected, by a team of experts, by applying the following criteria:

- Contribution of the service to the resilience of local populations to climate change,
- Availability of data.

These criteria were applied based on a subjective assessment grounded in the knowledge of local experts, rather than through the application of objective indicators. Given the relative lack of information about the values of ecosystem services in Mauritius, the most important criterion was availability of data. After a draft list of priority ecosystem services had been prepared by the experts, it was presented at a stakeholder consultation workshop held in Port Louis on 4 March 2022, where it was validated and weightings were given to each service, reflecting their relative importance for climate resilience.

The priority ecosystem services selected were (1) commercial fisheries, (2) water for domestic use, (3) water for irrigation, (4) water for hydropower, (5) protection against cyclones, (6) protection against floods, and (7) ecotourism.

3.2.3 Standardization of ecosystem services

Different source of data and formats were used to compile the data. Data normalization was necessary before being able to analyze them and to make meaningful comparison. Two normalizations were performed with the data; the latter was used for the final analysis:

- Normalization by percentage or relative abundance: each of the data will be reclassified to evaluate their relative importance, and thus the parameter value would be divided by the maximum value. A value between 0 and 1 will be obtained,

- Normalization by presence/absence: each ecosystem services will be reclassified in binary form: 0 if it is absent, and 1 if it is present.

3.2.4 Importance according to Ecosystem-based Adaptation (EbA)

During the first aggregations, each ecosystem service was evaluated according to its presence/absence and or abundance relative to the KBAs. While this technique indicates the relative importance of ecosystem services, expert scoring was used to provide balance and highlight the most important ecosystem services for the EbA.

Table 12 : Ecosystem services scoring for multi-criteria analysis

Ecosystem Service	Weight
PROVISIONING	**0.50**
1. Commercial fisheries	0.20
2. Water for domestic use	0.15
3. Water for irrigation	0.10
4. Water for hydropower	0.05
REGULATION & MAINTENANCE	**0.35**
5. Cyclone protection	0.20
6. Flood protection	0.15
CULTURAL	**0.15**
7. Ecotourism	0.15
TOTAL	**1**

3.3 Priority Ecosystem Services

3.3.1 Provisioning: Commercial fisheries

The fisheries sector represents an important economic sector of Mauritius; it generates employment, is a source of foreign income and ensures food security. Moreover, the fisheries sector contributes to about 1 % of our GDP and employs some 22000 people, working directly and indirectly, with the majority operating in the fish processing sector.

In 2019, local fish production was around 31,663 tonnes and total export of fish and fish products generated revenue of about Rs. 13 billion, contributing to about 19 % of our national exports. Furthermore, the fishery sector makes a vital contribution in the life of coastal communities by supporting livelihoods of coastal communities, tourism, and ensuring supply of fresh fish on the local market. Currently the fisheries sector is the mainstay of our Blue Economy.

The main types of fisheries practiced are namely: Artisanal fishery, Banks and chilled fish fishery, Tuna fishery, Deep-sea demersal fishery, FAD fishery and Aquaculture.

The KBAs most important for fisheries in Mauritius are the Cargados Carajos Shoals and the Rodrigues Islets, Mauritius South Eastern Islets and Mauritius Northern Islets.

The Cargados Carajos shoals (also known as St Brandon) has an area of 250 km^2 with a 190 km^2 reef surrounding it (nairobiconvention.org). It has sand flats on an extended reef system. There are two major fishing grounds in the archipelago: St Brandon up to South Albatross and the area north of Albatross. The sustainable yield of the two fishing grounds have been estimated to be around 1,280t (680t and 600t respectively for the two fishing grounds) based on historical data. (Albion Fisheries Research Centre of the Ministry of Fisheries, quoted by Outer Islands Development Corporation – govmu.org).

On the autonomous island of Rodrigues, which lies about 600 km north-east of Mauritius, fishing for octopus – locally called “ourite” – has been a traditional economic activity for generations. The fishing is carried out mainly by women walking on the reef flats of the gigantic lagoon that surrounds the island (240 km^2) and using metal sticks to search the dens in which octopus shelter. In the deeper parts of the lagoon, it can also be carried out using boats from which fishermen handle long spears. Traditionally sun-dried in the villages along the coast, octopus have in the last few decades been systematically collected in order to supply a handful of exporters who ship them, frozen, to Mauritius. A very organized octopus trade sector has therefore appeared, encouraging fishermen – professional or not – to catch more octopus (br81e.pdf – fao.org).

The Republic of Mauritius has a maritime jurisdiction which is more than 1,400 times larger than its land area. As such, fishing and shipping are among the main economic activities which are poised to boost the economy in this difficult economic climate that the country faces due to the COVID-19 pandemic. The development of the fisheries sector in particular is crucial for ensuring the food security of Mauritius. The annual per capita consumption of fish on the island is about 28 kg per person. Mauritius produces fish through coastal, demersal and pelagic fisheries, 86 % of which are sold on the local market and the remaining 14 % of are from marine aquatic farms aimed for international markets. Unfortunately, this is insufficient to meet local demand and our reliance on importation is therefore still very high. As a nation surrounded by the sea, it is felt that Mauritius should produce and consume more of local fish. The economic importance of the fisheries sector remains unexplored and full of lost opportunities. If Mauritius continues with the business-as-usual scenario, allowing and enabling foreign nations to exploit our marine resources, the country will miss the chance of unlocking the potential of the blue economy. (Anon 2021a). 184 fishers were registered for the Republic of Mauritius and there were 1009 registered fishmongers. A total amount Rs. 96 million (c. USD 2.5 m) was paid to fishermen for ‘Bad Weather Allowance’ (days when fishermen cannot fish due to bad weather or sea). In addition, a Solidarity Grant was paid to fishers of the South East Cost affected by the oil spill from MV Wakashio, amounting to Rs. 83.23 million (c.USD 2 m).

The artisanal fishery of Mauritius is confined mainly to the lagoon and near the outer reef areas. Artisanal fishermen use traditional means and methods of fishing, consisting of implements, such as basket traps, large nets, gill nets, canard nets, hooks and lines and harpoons. Fishing activities are carried out in wooden or fiberglass boats 6 -7 metres long and propelled by outboard motors, oars and sails and a few with inboard motors. Artisanal fishery remains the main source of fresh

fish supply to the local market. According to FAO, artisanal fishermen are those who are involved in fisheries which can be of subsistence or commercial type and provide for both local consumption and export, but catches are generally used or marketed locally. These fisheries typically use relatively small amounts of capital and energy, as well as small fishing vessels to make short fishing trips close to shore. As at March 2018, there were some 1,900 registered artisanal fishermen registered at 15 Fishing Posts around the island. They were classified based on their fishing grounds, namely Lagoon (72 or 4 per cent), Lagoon/Off Lagoon (1,110 or 58 per cent) and Off Lagoon (718 or 38 per cent). Lagoon fishermen are those who fish within the reef area in small embarkations, and Off Lagoon fishermen fish outside the reef up to some 20 kilometers and around FADs. Lagoon/Off Lagoon are registered to fish both inside and outside the reef (Anon 2018).

Fishers usually live close by the sea so that they are able to go to the sea easily. They live an uncertain life, with catches reliant on the weather, and are within the poorest segments of the population. The catches have been decreasing over the past decades, and many fishermen have to go further to fish. Lagoon fishing is on the verge of collapse in many regions due to overfishing, unsustainable fishing (eg use of small mesh for netting), El-Ninos, and dynamite fishing in the past. Fishers are encouragred to take advantage of ongoing schemes, such as the “Cannotte Scheme” (incentive to purchase fishing boat to be able to fish in the high seas) and the “Off Lagoon Semi Industrial fishing vessel scheme” to further develop their operations in this sector.

Fishing with nets in the lagoon was considered as a destructive method of fishing, and in the Master Plan 2012, it was recommended that closure of this type of fishery be considered. In 1996, management measures were taken to reduce the fishing pressure in the lagoon due to net fishing. These included a buy-back policy for large nets and gill nets, consisting of payment of compensation to fishermen who relinquished their net licences. Under the Rural Development Programme of the International Fund for Agricultural Development, funds were provided to reduce the number of nets in operation in Mauritius.

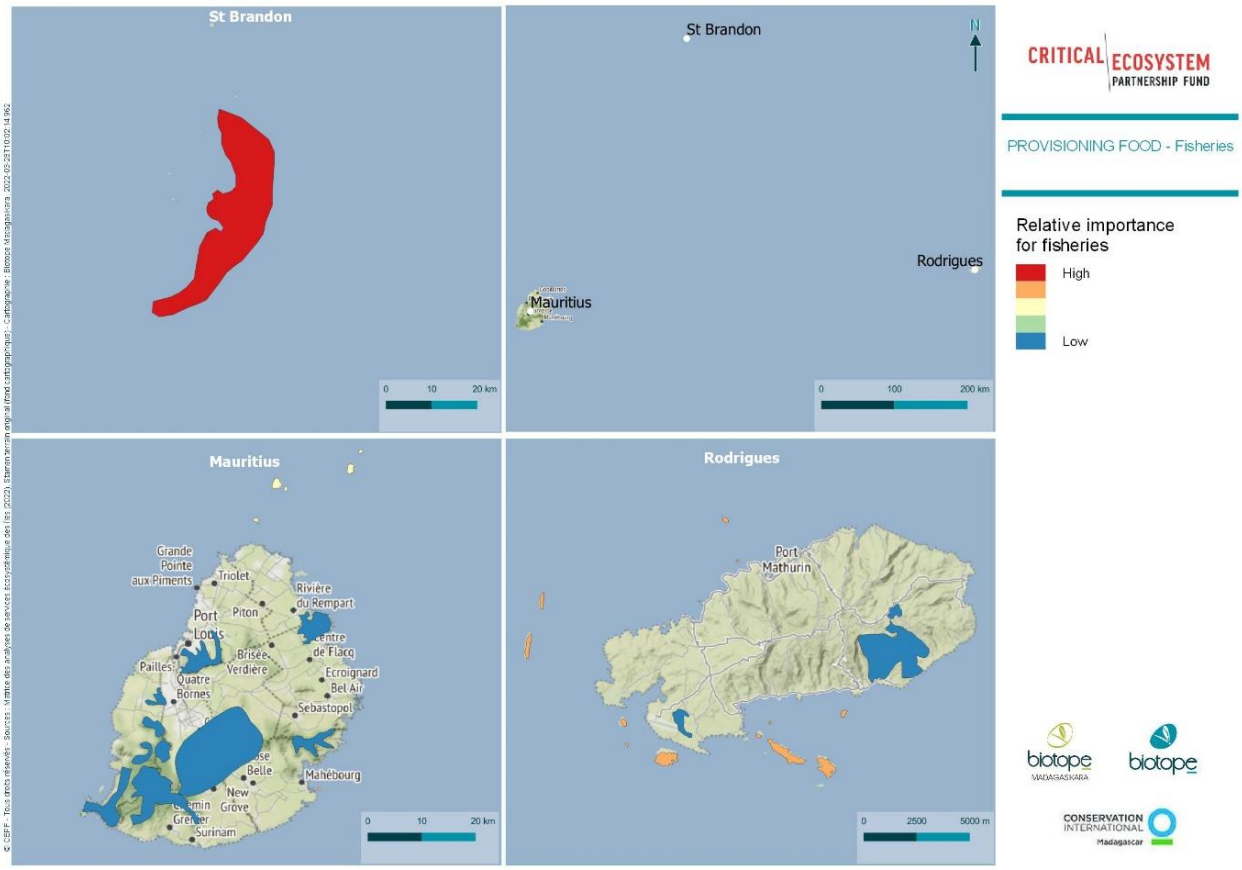
Table 13 : Production of fish (in wet weight equivalent) - Island of Mauritius, 2011 - 2020

(Tonnes)

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020 [1]
High seas [2]	**2,663**	**2,383**	**3,625**	**10,214**	**11,669**	**13,877**	**19,887**	**25,319**	**30,099**	**22,000**
Local vessels	2,663	2,383	3,625	10,214	11,669	13,877	19,887	25,319	30,099	22,000
Coastal Fishing	**2,100**	**1,888**	**1,749**	**1,649**	**1,799**	**1,804**	**1,758**	**1,745**	**1,722**	**1,133**
Lagoon and off lagoon	1,150	938	799	699	849	854	808	1,095	1,072	820
Sport fishing	650	650	650	650	650	650	650	350	350	88
Amateur fishing	300	300	300	300	300	300	300	300	300	225
Ponds and Barachois	**520**	**509**	**421**	**774**	**771**	**1,017**	**1,087**	**2,052**	**3,234**	**3,282**
Total production	**5,283**	**4,780**	**5,795**	**12,637**	**14,239**	**16,698**	**22,732**	**29,116**	**35,055**	**26,415**

[1] Provisional
[2] Includes fish caught for the canning industry
Source: Ministry of Blue Economy, Marine Resources, Fisheries and Shipping

Figure 14 : Map showing the importance of KBAs for commercial fisheries



Stakeholders assessed the importance of fisheries in KBAs. St Brandon KBA was evaluated as having the highest importance to fisheries supplies, as it is the main source of pelagic fish for Mauritius, especially of Lethrinus spp, known locally as ‘’La Perle’’ or ‘’Capitaine’’. Fish catch has been maintained at the threshold of 300 tons per year, as well as a steady production of good quality salted fish over the past decades. (stbrandon.com). Coastal KBAs of next level importance for fisheries are Rodrigues Islets and Southeast Islets, and finally Northern Islets KBAs. Rodrigues Islets KBAs are important for the supply of fish to Rodriguans and visitors to the island, who consume fish during their holidays or transport to Mauritius a chilled or salted fish.

The Southeast Islets KBA (Mauritius) provides fish to the Mahebourg region, known for its high number of fishers and proximity to the sea. The importance of fisheries to the local economy was felt during the Wakashio oil spill, when fishers could not fish due to a ban.

The Northern Islets KBA (Mauritius) supplies fish as well for hotels and Mauritians but is not as important as the other KBAs of relevance to fisheries.

Mainland Mauritius and Rodrigues KBAs are of low importance for fisheries, supplying more leisure fishing than quality or quantity of fish. Mainland fisheries on Mauritius provide fresh water fish such as native eels (*Anguilla* spp), and invasive Tilapia (*Oreochromis niloticus*), Common carp (*Cyprinus carpio*),crayfish (*Cherax quadricarinatus*).

3.3.2 Provisioning: Water for domestic use

Protected areas, although often terrestrially focused and less frequently designed to protect freshwater resources, can be extremely important for conserving freshwater biodiversity and supporting human water security necessary for people to survive and thrive. This study measured the quantity of water that is being provided by protected areas to areas downstream.

In Mauritius, the main source of domestic water supply is ground water (50%) which is abstracted through 163 boreholes. The remaining 50% is derived from surface sources such as impounding reservoirs and river intakes. (https://publicutilities.govmu.org/Pages/Water Sector/WRU.aspx)

Some of the key water resources statistics include:

- 25 major catchment areas,
- 24 minor river basins catchment areas varying from 3.9 to 173 km2,
- 107 flow measuring station,
- 350 river-run off takes, with an average annual mobilisation of 514 Mm3 of surface water,
- 7 major impounding reservoirs of a total capacity of 92.2 Mm3 and annual yield of164.4Mm3,
- There are 5 main aquifers in Mauritius, 604 boreholes (163 domestic (91%), 211 irrigation (4%), 230 industrial (5%)[1],
- Mare aux Vacoas is the largest reservoir in Mauritius, with a capacity of 25.89 million cubic metres and supplies water to the upper Plaines Wilhems and Moka.

Almost all major rivers are perennial with most of the streams having their source in the central plateau, and flow radially to the sea. The freshwater biodiversity of Mauritius is contained within 92 rivers and 232 rivulets, several manmade reservoirs, natural lakes and marshy areas. The island of Rodrigues has been divided into 20 major river basins and 10 minor ones, which have been for the most part that has dried up. There are no rivers or fresh water sources on St Brandon.

Table 14 : Capacity of man-made reservoirs in Mauritius

Reservoirs	Gross Capacity Mm^3
Mare aux Vacoas	25.89
Midlands	25.50
Mare Longue	6.2
La Ferme	11.52
Piton du Milieu	2.99
La Nicoliere	5.26
Tamarind Falls	2.3
Eau Bleue	6.2
Diamamouve	4.4
Dagotiere	0.6
Valetta	2.0
Total Storage Capacity	**92.86**

There are five main aquifers of Mauritius. The annual groundwater recharge has been estimated at 390 Mm3. Geological and hydrogeological investigations have resulted in the drilling of about 900 boreholes of diameter ranging from 150 to 300 mm. Presently, there are 339 boreholes in use as classified in Table 14.

Table 15 : No. of boreholes in use

Total No. of boreholes in use	339
No. of boreholes used for potable water (administered by CWA)	112
No. of boreholes used by industries	110
No. of boreholes used for Agricultural purposes	117

In addition to the 112 boreholes used for potable water supply, 18 other boreholes have been equipped as stand by. The maximum depth of borehole, which has been drilled so far, is 172 m. The maximum yield from a single borehole is 8000 m3 /day. The average annual volume utilised is 145 Mm3. The average annual contribution to potable water supply is 57%.

[1] https://publicutilities.govmu.org/Pages/Water Sector/WRU.aspx

Despite Mauritius receiving 2010mm of rain annually, there are annual and localised water shortages, especially during drought periods (usually September to December).

Table 16 : Water utilisation (Mm3 per year)

Purpose	Surface Water		Groundwater	Total
	River-run Off-takes	Storage		
Domestic, Industrial and Tourism	38[1]	48	113	199
Industrial (private boreholes)	-	-	10	10
Agricultural	370	76[2]	22	468
Hydropower	131	174[3]	-	305
Overall Utilisation	539	298	145	982
Total Water Mobilisation	514	230	145	889

[1] Includes 25 Mm^3 used for power generation at Reduit H.E.P.S
[2] Includes 30 Mm^3 used for power generation at Tamarind Falls and Magenta H.E.P.S
[3] Includes 38 Mm^3 used twice (14 Mm3 at Le Val and Ferney, and 24 Mm^3 at Tamarind Falls and Magenta H.E.P.S)

Water remains a high priority for the socio-economic development of Rodrigues (RRA 2009). Any obstacles that are being faced to solve them are hindering the progress and development of the island. So resolving the 'water issue' is key to the economic development of the agricultural, tourism and other related sectors. The standard of living and quality of life which Rodriguans are enjoying will be significantly enhanced with adequate water for domestic living and proper hygiene. about 62% of water is captured by surfaces and 38% by boreholes. The total storage capacity is estimated to be around 23,000 m3 while total demand revolves around 5,800 m3/day. Water supply varies between 4,500 m3/day in the dry period to 9,500 m3/day during the rainy season. This shows that water shortage is quite obvious in dry periods.

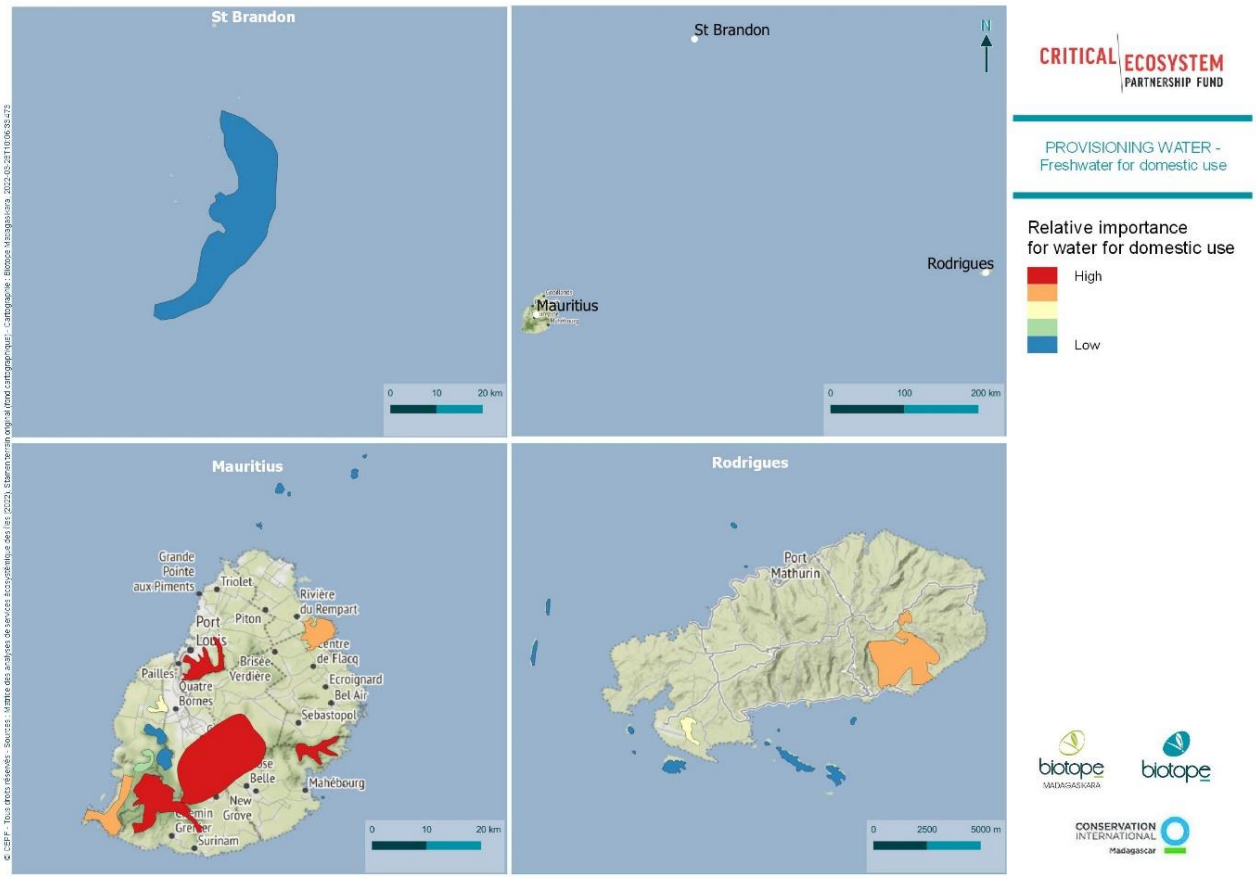
The ability of KBAs to provide domestic water was confirmed by stakeholders during bilateral meetings and the workshop to be of great importance. The KBAs that were identified as being key in Mauritius were found on the Central Plateau (Relict Forests of the Central Plateau) or straddled it (Black River Gorges National Park and surrounding areas, Le Pouce – Long Mountain, Bambou Mountain Range), which receives the highest rainfall. These KBAs are important for aquifer recharge, which provides the largest proportion of the Mauritian population with domestic water. For example, the Le Pouce-Long Mountain KBA supplies domestic water (in part) to the most densely populated district on Mauritius, Port Louis, which is also the capital lcity.

On Mauritius, Chamarel–Le Morne being on the leeward side of the island, and Plaine des Roches – Bras d'Eau KBA on the lowland dry coastal strip in the northeast, and both close to the coast, they are on the next lower level of importance for water provisioning.

On Rodrigues, the Grande Montagne KBA straddling the highest elevation on the island, is of importance to ground water recharge (hence domestic water provisioning), followed by the Plaine Corail KBA. The latter is pockmarked by caves and has a low population density, so the KBA is of lower importance for domestic water provisioning.

Of note, the islets KBAs do not have fresh water sources such as rivers and dams, and are uninhabited, so were not ranked to any significance by stakeholders. The dry coastal KBAs on west Mauritius (Corps de Garde Mountain and Yemen-Takamaka) are in the rain shadow and were not rated highly for domestic water provisioning.

Figure 15 : Relative importance of KBAs for water for domestic use



3.3.3 Provisioning: Water for irrigation

In practically every country, the claim is the same: all planters want as much water as possible, and at the lowest price. Mauritius does not escape the rule. The very nature of its agricultural background has resulted in an extensive irrigation system. The big sugar estates derive their water from riparian water rights (there is no tax on this water), as much of their lands is along the rivers. On the other hand, the government, through the Irrigation Authority, has planned irrigation schemes for the benefit of small planters. The water requirements in this sector would range from some 30 to 100 Mm^3. In the early days the required water was obtained from natural springs, streams or rivers in the proximity of the plantations, and few sugar cane growers had impounding reservoirs for storing their irrigation water. La Ferme and La Nicolière impounding reservoirs were constructed with the specific purpose of providing irrigation water for the sugar industry. Extensive systems of feeders (e.g. Nicolière feeder and La Ferme distribution canals) were also constructed for the supply to reservoirs and distribution of water on large areas. Irrigation projects are sometimes decided upon without the full backing of technical data. Observations that may be made relate to the may have been overlooked. As the population grows, the water available per capita inevitably decreases. In previous years water used for irrigation was three times more than the annual potable water consumption (domestic, touristic and industrial).

In 2019, the total area equipped for irrigation for Mauritius was 19 thousand hectares. Total area equipped for irrigation of Mauritius increased from 15 thousand hectares in 1970 to 19 thousand hectares in 2019 growing at an average annual rate of 0.52%[2]. The area equipped to provide water (via irrigation) to the crops includes areas equipped for full and partial control irrigation, equipped lowland areas, pastures, and areas equipped for spate irrigation.

[2] *Mauritius Total area equipped for irrigation, 1961-2021 - knoema.com*

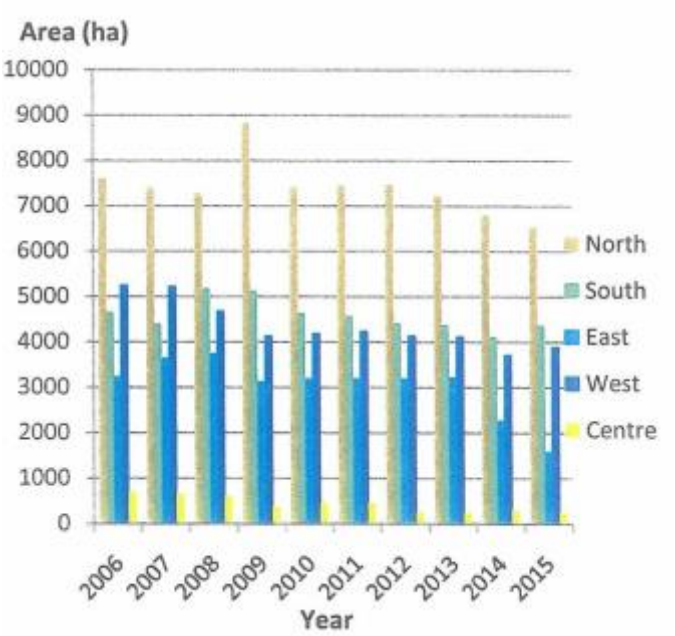
The Area equipped for irrigation in 2009 was 21 543 ha.[3] The irrigated area per region is visible in Table 16. About 98 percent of the area equipped for irrigation were actually irrigated. Groundwater was used for irrigation on 25 percent of the areas equipped for irrigation while the remaining areas were using water from surface water sources.

Table 17 : Distribution of irrigated agricultural fields on Mauritius (2009)

Region	Area equipped for irrigation (ha)
Centre	358
East	3 119
Northern	8 816
South	5 120
West	4 130
Mauritius total	**21 543**
with groundwater	5 386
with surface water	16 157

The graph below shows the distribution of irrigation projects on Mauritius (Anon 2016 : Annual Report 2014-2015.pdf (govmu.org))

Figure 16 : Area under Irrigation Regionwise



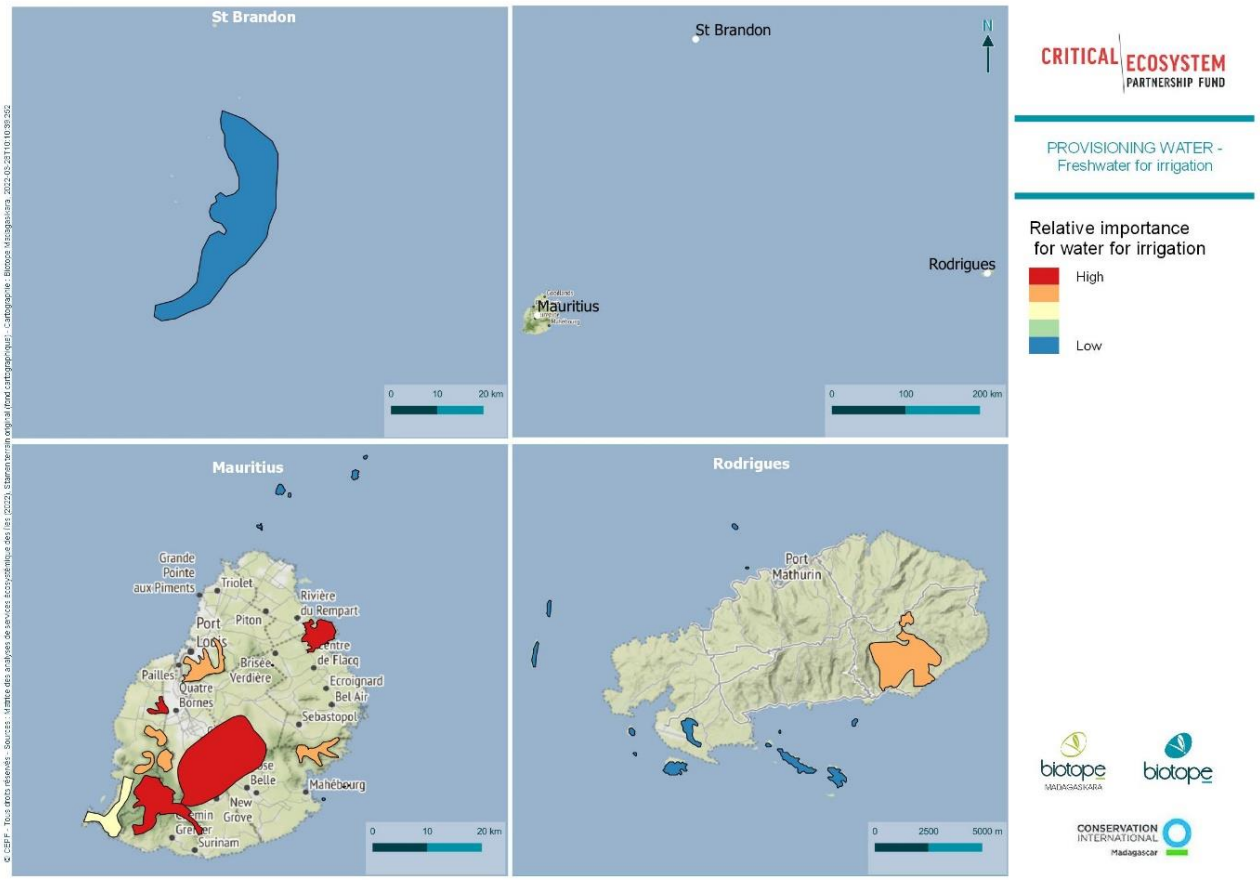
In Rodrigues, although agriculture has regressed dramatically in the past three decades (SIDPR 2009), there are good reasons, in the short term, for not neglecting the sector while developing the other ones. Too many families currently critically depend on agriculture for their livelihood. Even if the other sectors were to be developed as fast as is feasible, many of the current generation of agriculturalists cannot be reskilled in the short-term. However, in the long-term, this will have to be done for the new generation; currently, too, there is much unemployment and poverty. More than any other sector, agriculture can alleviate both problems, on condition that its weaknesses be addressed, and further opportunities be developed, particularly on the large area of land lying idle. The current use of water in agriculture is not sustainable either. The water balance is negative and, with the increasing pressure for water from other sectors – domestic, tourism, SME's – the availability of water for agriculture is not likely to increase. Consequently, the agriculturalists of the future must manage water optimally and not simply use, or even misuse, it. As elaborated further in the chapter on Water above, the change involves first stopping the

[3] *https://www.fao.org/aquastat/fr/geospatial-information/global-maps-irrigated-areas/irrigation-by-country/country/MUS/index.html*

wastage which is deemed to be quite common; second, introducing irrigation water dues, water being too precious a commodity to be given out freely; and third, as detailed below and in the Short-Term Action Plan (STAP), choosing crops, such as trees, and production methods, such as mulching, mini catchment and micro basins which are more adapted to the rainfall pattern.

No meaningful agriculture is practiced on St Brandon due to the small number of contractual fishermen, civil servants on short stays, no family set-up (there are no women or children on St Brandon), sandy susbtrate, uncertainty of rainfall, lack of fresh water source, and limited storage capacity etc. However, some kitchen farming is practiced.

Figure 17 : Relative importance of KBAs for water for irrigation



Stakeholders assessed KBAs in relation to their importance in provisioning irrigation water. The most important KBAs were Corps de Garde, supplying water to La Ferme Reservoir, which is used to irrigate the dry lands in the West of Mauritius. Relict upland forests KBA was reported to be important for irrigation, although the areas serviced by this KBA received much rainfall and are probably less needy of irrigation. A similar comment also applies to the Black River Gorges and surrounding areas KBA, although some of the water from this KBA drains to the dry west of Mauritius. The underground and surface water resources of Plaine des Roches KBA were important for irrigation of agricultural field in northeast Mauritius.

Next in importance were the following:

- *Bambou Mountain Range KBA*: close to the coast, and where there is some but not large agricultural activities (eg onion growing).
- *Three KBAs of close geographical proximity Tamarind Falls / Mount Simonet / Cabinet Nature Reserve Mondrain - Magenta - Trois Mamelles - Mont du Rempart Yemen-Takamaka* : they service irrigation to the west to variable extent. However, when combined, these three KBAs may have qualified as one of the most important.

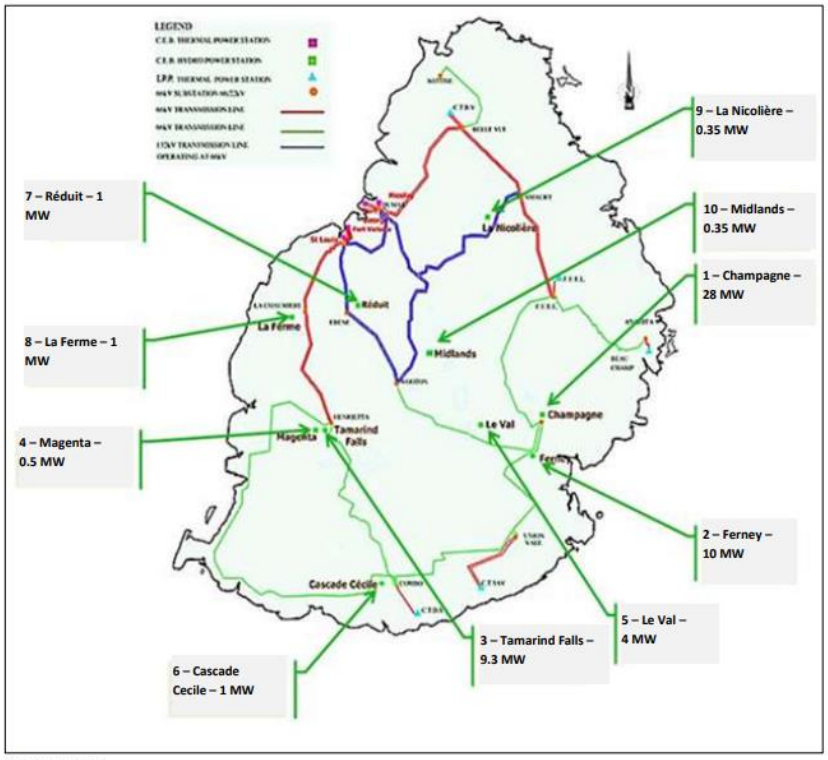
- *Le Pouce-Long Mountain KBA*: services the largest irrigated area of Mauritius i.e. the Northern Plains, which also contains the Nicoliere Dam. This same KBA supplies irrigation water to the Port Louis and northwest area of Mauritius, although these areas are smaller than the Northern Plains. May have qualified as one of the most important KBAs for provisioning of irrigation water.
- *South Slopes of Grande Montagne (Rodrigues)*: provides irrigation water for farmers between Graviers and Mourouk.
- Chamarel – Le Morne KBA: There is only a little agriculture practiced, downstream from the KBA, which justifies a low importance given to the KBA in terms of irrigation.

The remaining KBAs, consisting mainly of island KBAs and two mainland KBAs (Plaine des Roches and Pont Bon Dieu) are of little or no importance to irrigation.

3.3.4 Provisioning: Water for hydropower

Due to volcanic formation of Mauritius, we do not possess natural underground sources of energy like coal, oil or uranium. Water has been until recently, however, a non-negligible source of power in the form of its hydroelectricity potential (Proag 2006). The use of hydropower for electricity generation dates as far back as 1899 when electricity was first produced in Mauritius.(Anon 2019b). It was the major renewable energy source for power generation contributing as much as 50- 60% of the electricity mix in 1968. The amount of hydropower generated is dependent on several factors such as rainfall, water storage levels and water demand from mainly agricultural and potable use. However, climate change with prolonged dry periods and reduction in rainfall poses a significant challenge to the availability of water resources and hence, for hydropower generation. Hydropower is harnessed through the gravitational force of falling or flowing water. There are two types of hydropower plants, namely conventional and non-conventional ones. The conventional power stations can be further sub-categorised into impounded and diversion, of which the impounded facility is the most common. These hydropower plants vary in size, ranging from small systems to large utility scale projects, of capacities of ≤30 MW and >30 MW respectively (Anon 2021b). The small hydro systems can be further sub-divided into mini (100 - 1000 kW), micro (Figure below).

Figure 18 : Hydropower stations in Mauritius



Data Source: CEB

Hydroelectric power generation accounted for 3.0% of total electricity produced in 2019. Fluctuations in hydroelectric power generation tend to follow annual rainfall levels. The electricity generated from all the hydropower plants was 98.6 GWh in 2019. In a rainy season, the annual production can be as high as 125 GWh, while in a dry season, it can drop to 57 GWh. On an average therefore, some 90 GWh annually is considered in a normal rainfall year.

The primary energy requirements are met from imported sources and from local renewable sources as shown in Table 17.

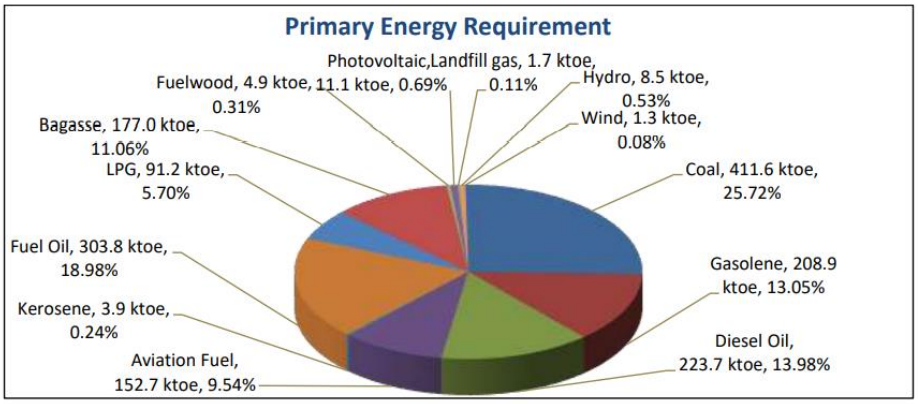
Table 18 : Primary energy requirement 2018 - 2019

	Energy source	Primary energy requirement (ktoe)		% change
		2018	2019	
Imported fuels	Coal	447.7	411.6	-8.1 %
	Gasolene	191.5	208.9	9.1 %
	Diesel Oil	216.6	223.7	3.3 %
	Aviation Fuel	162.5	152.7	-6.0 %
	Kerosene	0.7	3.9	457.1 %
	Fuel Oil	278.7	303.8	9.0 %
	LPG	84.2	91.2	8.3 %
	Sub Total	***1,381.9***	**1,395.8**	1.0 %
Local resources	Bagasse	180.1	177.0	-1.7 %
	Fuelwood	6.1	4.9	-19.7 %
	Photovoltaic	4.2	11.1	164.3 %
	Landfill gas	1.9	1.7	-10.5 %
	Hydro	10.7	8.5	-20.6 %
	Wind	1.3	1.3	0.0 %
	Sub Total	***204.4***	**204.5**	0.0 %
TOTAL		**1,586.3**	**1,600.3**	**0.9 %**

Data Source: Statistics Mauritius

Figure 19 shows the share of fuel source in the primary energy requirement for year 2019.

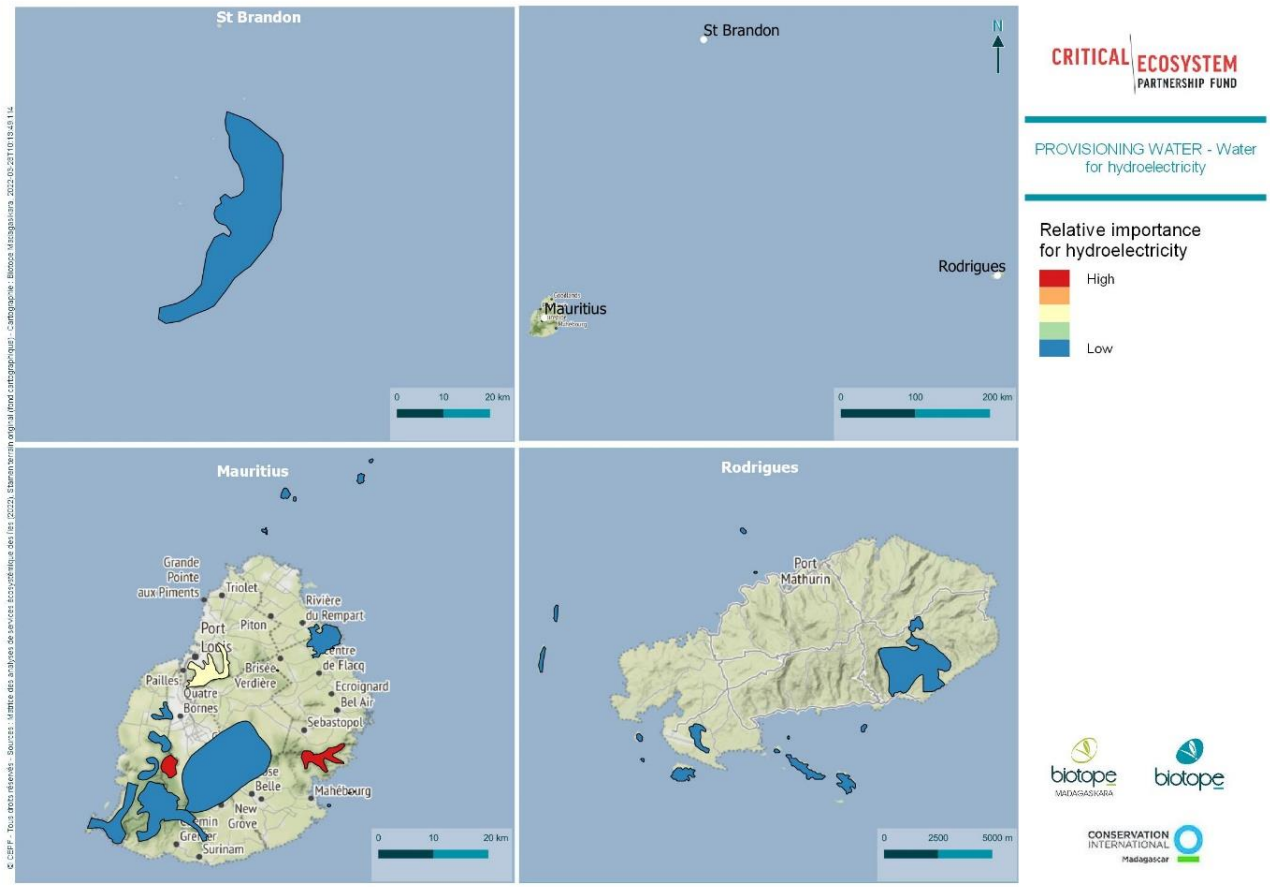
Figure 19 : Primary Energy Requirement 2019



Data Source: Statistics Mauritius

There is no hydroelectric power generation in Rodrigues, and 12.3 of the 14.1 ktoe requirement was met by diesel and fuel oil (Anon 2021b).

Figure 20 : Relative importance of KBAs for water for hydropower



Stakeholders in Mauritius evaluated the value of KBAs in terms of hydroelectric power generation.

Bambous Mountain Range KBA was assessed as being important for hydroelectricity, as it contains Champagne, Ferney, and Le Val powerstations (Fig 18). Tamarind Falls / Mount Simonet / Cabinet Nature Reserve KBA was also ranked highly, as it hosts the Tamarind Falls power station.

Of lower importance were, Le Pouce - Anse Courtois - Pieter Both -Longue Mountain KBA which contains the Réduit power station and Pont Bon Dieu KBA which appears to be connected to La Nicoliere, and hence the power station.

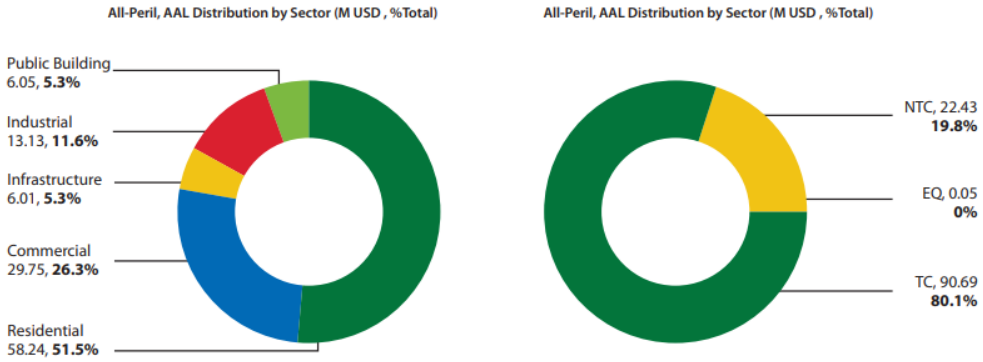
3.3.5 Regulation and maintenance: Cyclone protection

The climate of the Republic is mild tropical. Mauritius island has two seasons, a warm summer from November to April and a dryer, cooler winter from May to October. Long term mean annual rainfall (1961-2007) is 2,010 mm. Precipitation averages 1,344 mm in the summer and 666 mm in winter. For Rodrigues Island, long term mean rainfall (1961-2007) is 1,116 mm, with 65% falling during the summer. For Rodrigues Island, long term mean rainfall (1961-2007) is 1,116 mm, with 65% falling during the summer. The cyclone season across the Republic is November to April, although severe storms can occur in any month. The frequency of extreme weather events, heavy rains and storms of tropical cyclone strength or higher, has increased significantly over the last two decades. Recent studies carried out by the Mauritius Meteorological Services (MMS) clearly shows an increasing trend in the number of storm formations over the last 32 years, as well as the number of storms reaching tropical cyclone strength. Recent studies carried out by the Mauritius Meteorological Services (MMS) clearly shows an increasing trend in the number of storm formations over the last 32 years, as well as the number of storms reaching tropical cyclone strength (winds above 165 km/hr). A plot of the number of storm formations over the last 32 years (1975- 2008) clearly shows an increasing trend in the number of storms reaching tropical cyclone strength (winds above 165 km/hr). Furthermore, since the last decade observations indicate rapid

or even explosive intensification of tropical storms (metservice.intnet.mu/climate-services/climate-change.php).

Mauritius experiences on average over USD110 million in combined direct losses from floods and tropical cyclones each year. According to the risk profile the residential sector experiences over 50% of the combined losses and the commercial sector over 26%.

Figure 21 : Average Annual Loss Distribution in Mauritius by sector and by peril

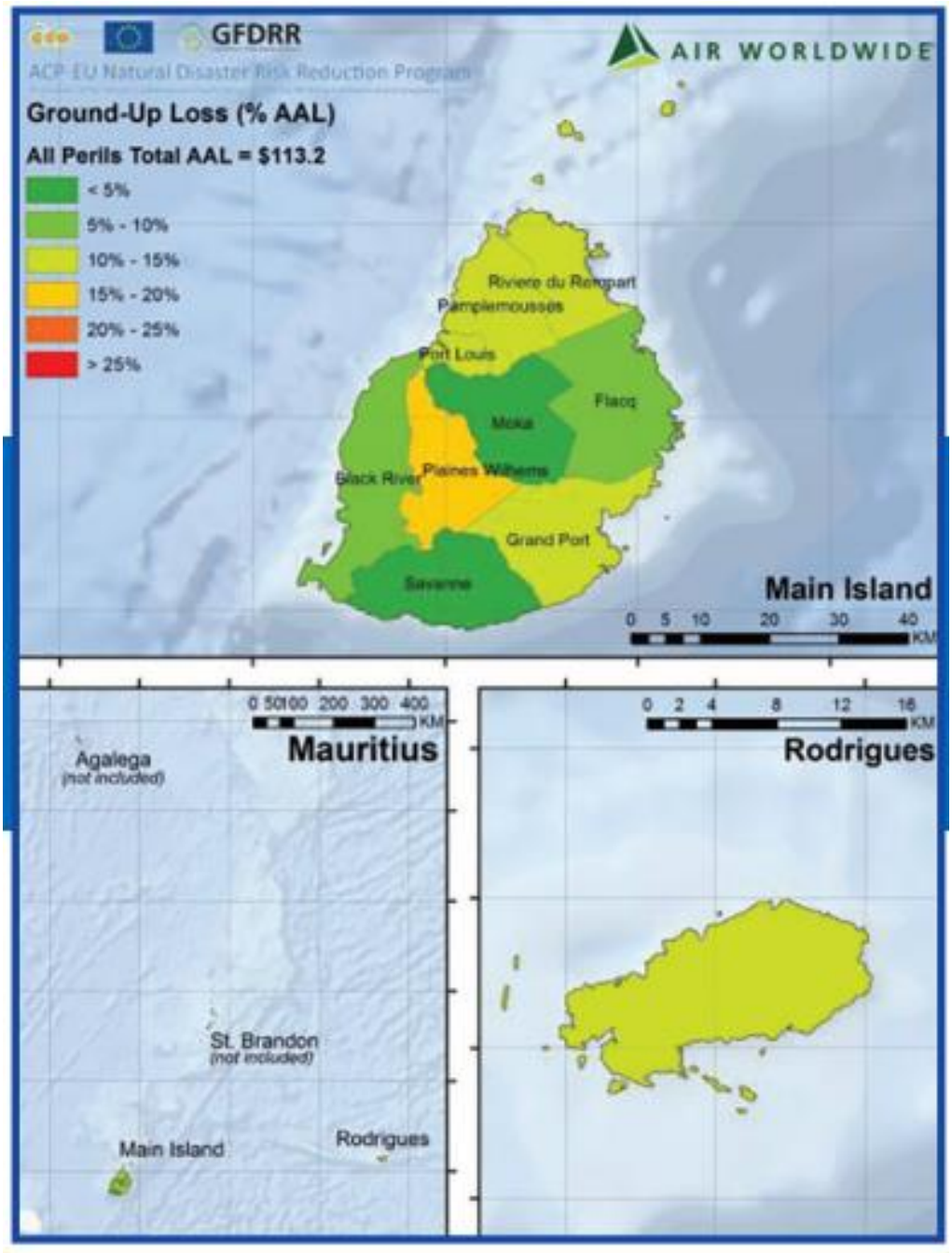


Tropical cyclones are by far the most significant risk, causing approximately 80 percent of the average annual loss per year (World Bank 2017). Flooding is the next largest risk, accounting for nearly 20%. However, infrequent (i.e., higher return period) cyclone events are expected to generate significantly higher losses than similarly infrequent non-tropical cyclone floods. Table 3.3 summarizes the annual probability of exceeding the ground-up losses generated by each modeled peril and for all modeled perils combined, for the Average Annua Loss (AAL) as well as higher return periods. Groundup losses are the expenditures needed to repair or replace the damaged assets, while emergency losses are the expenditures incurred in the aftermath of a natural catastrophe, which include relief and post-disaster activities.

Table 19 : Natural catastrophe risk profile for Mauritius

Exceedance Probability:	AAL	0.1	0.04	0.02	0.01	0.004	0.002
Mean Return Period (years):		10	25	50	100	250	500
Risk Profile: All Modeled Perils (AP)							
Ground-up Loss (M USD)	113.2	145.2	356.8	800.6	1,906.5	3,642.3	5,730.4
(% Total Exposure Value)	0.3%	0.4%	1.1%	2.4%	5.7%	10.9%	17.1%
Emergency Loss (M USD)	26.0	33.4	82.1	184.1	438.5	837.7	1,318.0
Risk Profile: Tropical Cyclone (TC)							
Ground-up Loss (M USD)	90.7	97.3	329.1	757.3	1,880.7	3,632.9	5,702.3
(% Total Exposure Value)	0.3%	0.3%	1.0%	2.3%	5.6%	10.9%	17.0%
Emergency Loss (M USD)	0.0	0.0	75.7	174.2	432.6	835.6	1,311.5
Risk Profile: Non-Tropical Cyclone Flood (NTC)							
Ground-up Loss (M USD)	22.4	63.0	100.5	126.1	149.7	179.5	203.5
(% Total Exposure Value)	<0.1%	0.2%	0.3%	0.4%	0.4%	0.5%	0.6%
Emergency Loss (M USD)	5.2	14.5	23.1	29.0	34.4	41.3	46.8
Risk Profile: Earthquake (EQ)							
Ground-up Loss (M USD)	0.1	0.0	0.0	0.0	0.0	0.0	0.0
(% Total Exposure Value)	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%
Emergency Loss (M USD)	0.0	0.0	0.0	0.0	0.0	0.0	0.0

This analysis also shows that for example a 100-year return period tropical cyclone event could produce direct losses of USD1.9 billion, equivalent to 16 percent of the 2015 GDP, and require approximately USD430 million in emergency costs. Particularly for tropical cyclones, the exposure normalized losses in Mauritius tend to be higher than many of the other SWIO Island States due to relatively concentrated exposure, which can be impacted in its entirety by a single event.



The highest losses take place on the Main Island, which experiences nearly 90% of the AAL for the three persils combined, with the remaining losses occuring on Rodrigues. In addition to the direct losses, an annual average of nearly USD26 million is estimated for emergency costs.

Tropical cyclones affect nearly every aspect of the ecosystem services that mangroves provide; for example, in protecting infrastructure, in provisioning of wildlife habitat and in carbon sequestration.

Sauer (1962) identified two species of mangroves, Bruguiera gymnorrhiza (L.) Lam., and Rhizophora mucronata Lam. The latter species is more dominant (Fagoonee, 1990) and occurs in pure stands in most of the swamps (Poonyth, 1998). The Rhizophora belt along Mauritian coastal line is narrow owing to low tidal range of 0.5m and topographical features. Mangroves are found in estuaries and sheltered lagoons. Mangroves cover an area of about 20 km2 in Mauritius. Rhizophora mucronata is found on the Northeast, East, Southeast coast of Mauritius (extending

from Grand Gaube, Pointe des lascars, Poste la Fayette, Ile aux Cerfs, Trou D'eau Douce, Beau Champ, Grand Sable, Mahebourg), some patches occur in the South–Southwest coasts (Maconde, Tamarin). Small patches of Bruguiera gymnorrhiza occur at Pointe la Fayette, Trou D'eau Douce, Ferney and Mahebourg, on the East Coast. The heights of the mangroves range from 2-7 m on the East Coast (Anon, 1991a).

Mangroves play an important role in the coastal ecosystem of Mauritius and in the state of the environment report (Anon, 1991), their importance is listed as follows: 1. They prevent coastal erosion and dampening action of waves on coastline. 2. They retain terrigeneous sediments, thereby protecting the lagoons from the effects of sediments. 3. They provide habitats and nursery grounds for crabs, shrimp and juvenile fish. 4. They provide substrates for fixation of oyster spat. 5. They provide food in the form of leaves and offering detritus trapped among their roots for a number of marine organisms. (Appadoo 2010).

Mangroves are found on the front line in terms of their position relative to many coastal hazards. The fact that they thrive in many coastal settings give some indication of their ability to cope with such hazards, or at least to recover from major impacts. Mangroves often modify coastlines through their ability to attenuate waves, capture sediments and build soils and it is these same properties which make them important in terms of reducing hazard intensity on landward margins and of decreasing exposure. They also provide many associated benefits that can help reduce the vulnerability of coastal communities and support recovery following hazard impacts. (Spalding et al. 2014).

The role of mangroves in protecting our coasts against natural hazards such as storms, tsunamis and coastal erosion has been widely acknowledged. The role of mangroves in coastal risk reduction include:

Wind and swell waves are rapidly reduced as they pass through mangroves, lessening wave damage during storms.

Wide mangrove belts, ideally thousands of meters across, can be effective in reducing the flooding impacts of storm surges occurring during major storms (also called cyclones, typhoons or hurricanes). This can significantly reduce flood extent in low lying areas. Narrower mangrove belts, hundreds of meters wide, will still be able to reduce wind speed, the impact of waves on top of the surge and flooding impact to some degree.

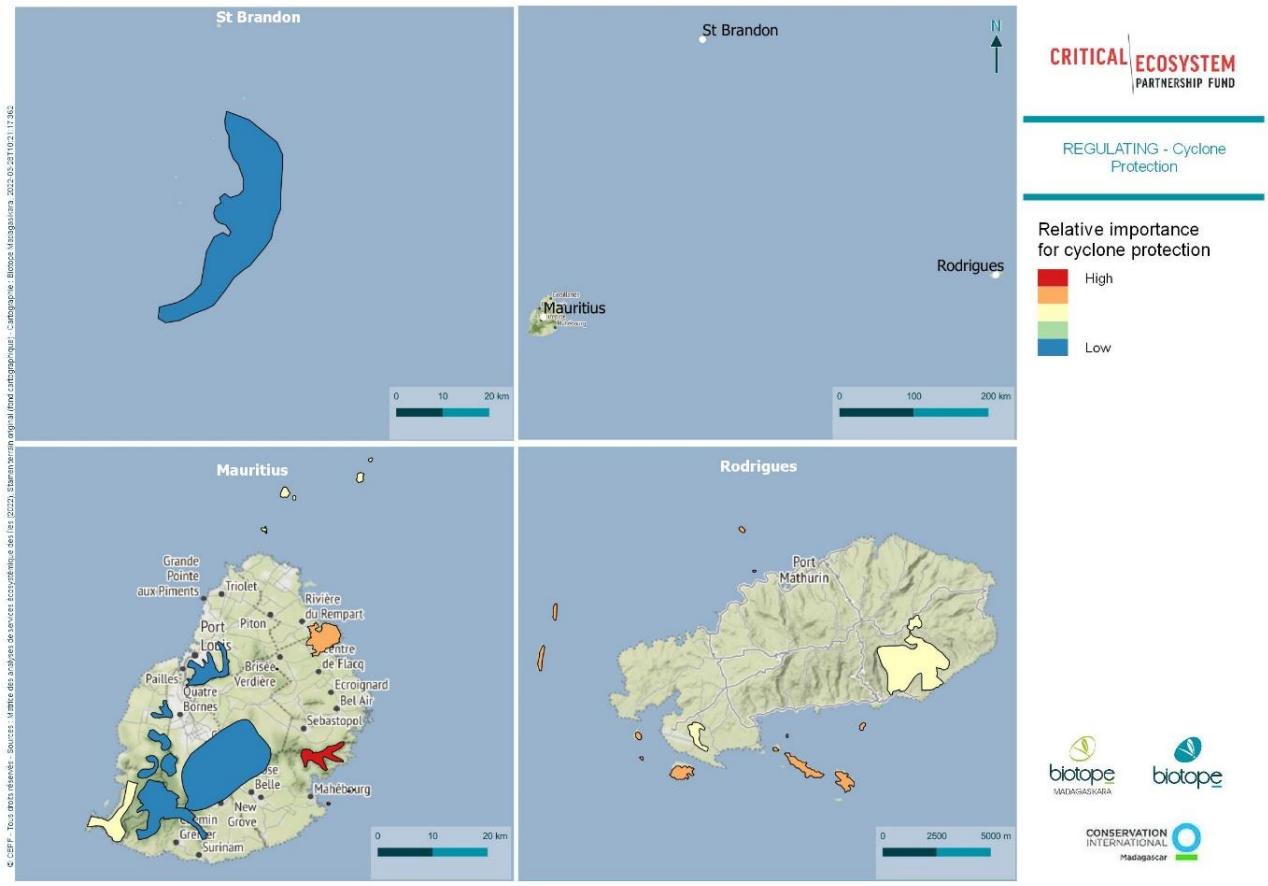
Wide areas of mangroves can reduce tsunami heights, helping to reduce loss of life and damage to property in areas behind mangroves.

The dense roots of mangroves help to bind and build soils. The above-ground roots slow down water flows, encourage deposition of sediments and reduce erosion.

Over time mangroves can actively build up soils, increasing the thickness of the mangrove soil, which may be critical as sea level rise accelerates (Spalding 2014)

Research and experience have shown that forest ecosystems play an important role in reducing the vulnerability of communities to disasters, both in terms of reducing their physical exposure to natural hazards and providing them with the livelihood resources to withstand and recover from crises. (IUCN/WWF 2005).

Figure 22 : Relative importance of KBAs for cyclone protection



Cyclone protection can be offered by mangroves, reefs and forests. KBAs are either battered by cyclones, unable to offer protection, or are offer resistance and protection from cyclones. Stakeholders assessed KBAs in relation to cyclone protection.

The Bambou Mountain Range KBA and Southeast Islets KBA, were assessed as being the most important for cyclone protection. The prevailing winds in Mauritius come from the southeast but during a cyclone, winds can come from other directions, and changes depending on the movement of the cyclone. Nevertheless, it was felt that the coral reefs in the vicinity of the southeast islets protect from cyclonic swells, as well as the Bambou Mountain Range which protect the inland due to the forested cliffs. The coastline is close to the Bambou Mountains and lined with mangroves, which protect coastline and villages from cyclones.

Rodrigues Islets KBA with the wide lagoon that they rest upon attenuates cyclonic swells that otherwise will have affected the coastline of Rodrigues to a greater extent. The introduced mangroves Rhizophora mucronata, growing on west and southwest Rodrigues also protect from cyclone surges. Plaine des Roches-Bras d'Eau KBA coastline to the east is lined with mangroves that offer cyclone protection.

At the next level down, Chamarel-Le Morne KBA, Northern Islets KBA, Plaine Corail KBAs lagoons, and Grande Montagne KBA inland forest attenuate cyclonic winds.

Other mainland Mauritius KBAs were thought to resist cyclones and provide protection to biodiversity and people.

3.3.6 Regulation and maintenance: Flood protection

Mauritius is affected by the adverse effects of climate change, such as temperature rise, sea level rise and increase in frequency and intensity of extreme weather events, like flash floods. According to the National Disaster Risk Reduction and Management Council, in the Republic of

Mauritius, flooding that are caused by heavy/torrential rains account for more than 70 per cent of disaster event every year. Of the several flash floods experienced by the country, the one that occurred in Port-Louis on 30 March 2013 caused one of the highest fatalities. In addition, according to the Disaster Risk Reduction Strategic Framework and Action Plan (DRR Report 2013), it has been estimated that damages to buildings and infrastructures due to flooding in the next 50 years will cost around US $ 2 billion for Mauritius. (Anon 2019)

The study carried out by the Environment and Sustainable Development Division of the Ministry of Social Security, National Solidarity and Environment and Sustainable Development (MoESD) on the real causes of flooding in February 2016 at 128 affected regions revealed that regions in low lying areas account for 50 per cent of the cases, while in the others, they were due to drainage issues with new development, capacity of drainage network, development in backfilled ex-wetland and flooding of river floodplain. Since 2003, these causes had already been highlighted in the report of the National Development Strategy and Policies of the Ministry of Housing and Lands. Some 15 years after since the causes were identified by the Ministry of Housing and Lands, in July 2018, during a meeting of the Technical Committee on Legal Assistance at the National Development Unit (NDU), members were still raising issues, such as improper inventory of drains and canals, inadequate maintenance and cleaning of drains, surface run off from sugar cane fields, backfilling of wetlands being persistent, and for new developments, there was no proper plan for channelling storm water overflowing from absorption drains.

For the period 2015-16 to 2017-18, the NDU spent some Rs 594.1 million on construction and upgrading of drains. For Local Authorities, the total amount spent on the construction of drain was some Rs 279 million, and some Rs 37 million on cleaning of drains, rivers and canals during financial years 2016-17 and 2017-18. However, these works were undertaken following flood events and was of a reactive nature rather than pro-active.

Development is controlled to some extent through the National Ramsar Committee which oversees wetland management by providing Ramsar Clearance. In the Environment Protection Act, which provides for the requirement of an Environment Impact Assessment (EIA) for development in wetlands, backfilling of a wetland without a Preliminary Environmental Report or EIA is an offence under the Act. Moreover, in the National Development Strategy 2003, it is stated that the provisions of the Rivers and Canal Act which prohibit the construction of a building within 16, 8, 3 metres of a river, stream and canals should be complied with.

In spite of these controls, stakeholders were facing difficulties in managing wetlands for the following reasons:

- As at September 2018, an updated inventory on wetlands was not available for stakeholders to take appropriate decision with regard to their management
- In a Study on Environmentally Sensitive Areas (ESA) carried out in 2008, it was recommended to have an Environmentally Sensitive Areas Act to better manage ESAs, including wetlands. However, since 2009, some nine years after the completion of the ESA Study, an Environmentally Sensitive Areas Act had not yet been adopted [still the case in 2022].
- To better manage wetlands, the preparation of a draft Wetland Bill started prior to 2005. However, as at September 2018 [and even in 2022], it had not yet been finalised.
- There was no clear demarcation as to who was responsible to carry out post monitoring to ensure compliance with the conditions of the Ramsar clearances and licences issued. Hence, post monitoring of these clearances was not being carried out. [still the case in 2022].

Figure 23 : Causes of flooding

Causes of Flooding	No. of Cases	% Occurrence
Topography – Low Lying Areas	64	50
Drainage Issues with new Development	26	20
Capacity of Drainage Network	23	18
Development in Backfilled ex-Wetland	10	8
Flooding of River Floodplain	5	4
Total	**128**	**100**

Source MoESD

Far from being useless, disease-ridden places, wetlands provide values that no other ecosystem can. These include natural water quality improvement, flood protection, shoreline erosion control, opportunities for recreation and aesthetic appreciation and natural products for our use at no cost.

Wetlands function as natural sponges that trap and slowly release surface water, rain, snowmelt, groundwater and flood waters. Trees, root mats and other wetland vegetation also slow the speed of flood waters and distribute them more slowly over the floodplain. This combined water storage and braking action lowers flood heights and reduces erosion.

Wetlands within and downstream of urban areas are particularly valuable, counteracting the greatly increased rate and volume of surface- water runoff from pavement and buildings. The holding capacity of wetlands helps control floods and prevents water logging of crops.

A study commissioned by the Ministry of Environment concluded that the loss of 70 % of wetland extent in a northern coastal region was directly related to flooding problems in this area (MOE and GIBB 2002).

A total of 144 wetlands were digitized (Fig. 2 ; Mamoun et al. 2013) while the distribution of wetlands in regions (north, east, west, etc.) is summarized in Table 1. The total surface area of wetlands is ~18.39 km^2. By excluding reservoirs, natural wetlands occupy 6.39 km^2, which is 0.34 % of the total surface area of Mauritius, thus emphasizing the very small extent occupied by wetlands in Mauritius. The predominant wetland class is marshes and swamps, represented by 55 features and totalling a surface area of ~2.4 km^2, or 38 % of the total (natural) wetland surface area. The others are: Depressions (27), Estuaries (22), Mangrove (16), Reservoirs (8), Floodplains (7), Marine coasts (6) and lakes (3). From a geographic point of view it can be observed that most wetlands are situated in the northern, eastern and south-eastern coastal plains with wetland distribution as follows: east (42 wetlands), north (31) and south-east (22).

Figure 24 : Map showing the location of wetlands

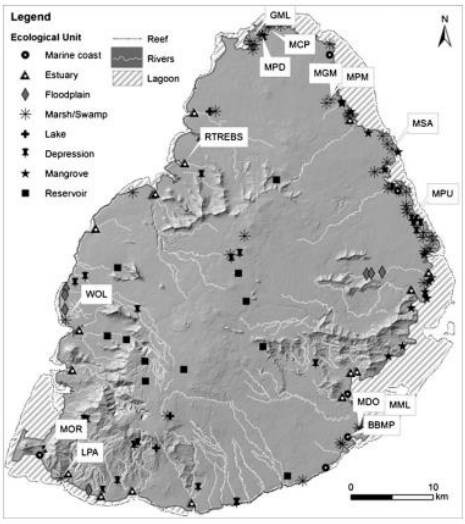


Table 20 : Distribution and classification of the 144 wetlands inventoried. Distribution is a basis, with, north (N), etc. Classification is into 8 'ecological' wetland types found exhaustive to classify all of the wetlands of the island

Ecological units	Area km^2	Region								
		N	NW	E	SE	S	SW	W	CP(L)	CP(W)
Marine coasts	1.18	2	–	–	3	–	1	–	–	–
Estuaries	0.95	2	2	2	7	3	1	5	–	–
Floodplains	0.62	–	–	3	–	1	–	3	–	–
Marsh/Swamp	2.4	19	–	21	8	1	1	2	2	1
Lakes	0.25	1	–	–	–	2	–	–	–	–
Depressions	0.5	2	1	7	1	7	3	2	2	2
Mangroves	0.49	4	–	9	3	–	–	–	–	–
Reservoirs	12	1	–	–	–	–	–	1	4	2
Total	18.39	31	3	42	22	14	6	13	8	5

Wetlands, rivers, drains in Mauritius play an important role in flood prevention. Mauritius has some 25 major and 21 smaller rivers and numerous canals, and other drains. These help to reduce the risk of flooding. According to the Land Drainage Authority, there are some 33 flood prone regions in Mauritius, and three in Rodrigues:

1) Vallée-Pitot ; 2) Tranquebar ; 3) Centre de Port-Louis ; 4) Morcellement La Vallée Le Cornu Sainte-Croix ; 5) Canal Anglais ; 6) Cité Richelieu ; 7) Fond du Sac ; 8) L'Amitié ; 9) Cité EDC-Cottage ; 10) La Paix, Piton ; 11) Cité Roma Riche-Terre ; 12) Morcellement Raffray et Tara, Terre-Rouge ; 13) Belle Source, Pamplemousses ; 14) Kestrel Lane, Terre-Rouge ; 15) Cité Nelson Mandela, Terre-Rouge ; 16) Baie du Tombeau ; 17) Camp La Cloche, Pointe-aux-Piments ; 18) Petite-Julie ; 19) Camp Thorel ; 20) Poste-de-Flacq, Allée Mangues ; 21) Poste-de-Flacq ; 22) Bramsthan ; 23) Trois Boutiques ; 24) Plaine-Magnien ; 25) Mare-Tabac ; 26) Nouvelle-France ; 27) Gébert, Gros Billot, New Grove ; 28) La Flora ; 29) Cité La Ferme, Bambous ; 30) Morcellement Chazal, Flic-en-Flac ; 31) La Louise, Quatre-Bornes ; 32) Avenue Berthaud, Quatre-Bornes ; 33) Canal Alliman ; 34) ; Grand La Fourche Mangues, Rodrigues ; 35) Port-Mathurin et ; 36) Baie-Malgache.

From the above, some of these are associated with KBAs, for example:

Le Pouce-Long Mountain KBA: 1) Vallée-Pitot ; 2) Tranquebar ; 3) Centre de Port-Louis ; 4) Morcellement La Vallée Le Cornu Sainte-Croix ; 5) Canal Anglais Cité Roma Riche-Terre ; 12) Morcellement Raffray et Tara, Terre-Rouge ; 13) Belle Source, Pamplemousses ; 14) Kestrel Lane, Terre-Rouge ; 15) Cité Nelson Mandela, Terre-Rouge ; 16) Baie du Tombeau ;

Bambou Mountain Range KBA: Plaine-Magnien, New Grove, Cité La Ferme, Bambous ;

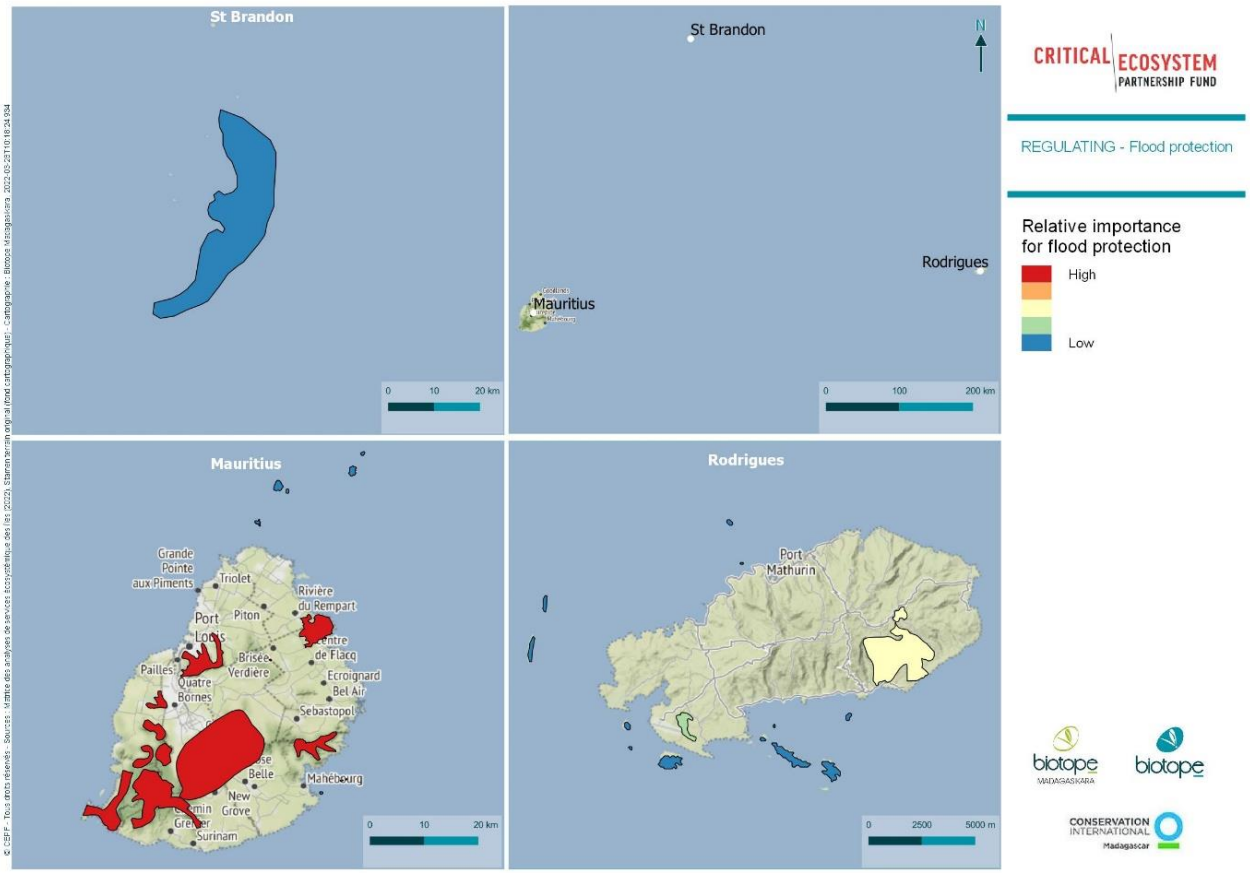
Relict Forest of Central Plateau : Camp Thorel ; Nouvelle-France ; La Flora ;

Corps de Garde KBA : Morcellement Chazal, Flic-en-Flac ; 31) La Louise, Quatre-Bornes ;

From the above, protection of KBAs would greatly help to reduce flooding risks.

The stakeholders agreed that all of the mainland KBAs offered flood protection, with 11 KBAs at the highest level in Mauritius. In Rodrigues, Grande Montagne KBA and lastly Plaine Corail KBA were assessed as being less important for flood protection. Islet groupings were all assessed as not offering protection from floods.

Figure 25 : Relative importance of KBAs for flood protection



3.3.7 Cultural: Ecotourism

As awareness grows of the importance of maintaining the island's ecosystem, for its flora, fauna, and population, Mauritius is promoting green tourism.

Eco-friendly activities offered to tourists are beginning to define the island in more depth too. As well as beach relaxing, there are sea sports including windsurfing, sailing, kayaking and diving, and the land pursuits, mountain biking, hiking, ziplining and canyoning. Local and carbon-free transport is being promoted over private vehicles and there is also a drive to employ locals and to source local ingredients as much as possible.

There are over 160km of beautiful beach, including a lagoon protected on all sides by an encircling coral reef. The north has a huge number and variety of beaches, including small, secluded coves. The east has some stunning beaches. The west offers the best sunsets as well as warm shallow waters, whilst surf fans prefer the wilder south.

Mauritius has seen a sharp decrease in its coral reef, due to climate change and aggressive fishing methods. The Mauritius Marine Conservation Society, and reef and lagoon volunteering projects, are working hard to raise awareness and protect the marine environment for years to come. Coral nurseries are growing new corals for rejuvenation efforts and stricter rules and regulations on fishing mean there's renewed hope for Mauritius' reefs.

The Mauritian Standard on Sustainable Tourism (MS 165:2019) was developed to guide the sustainable development of the tourism industry in Mauritius. (gstcouncil.org).It is meant for any tourism business or any tourism-related activity to enhance its sustainability performance. The focus of the Sustainability Tourism Standard is to address requirements of the environmental impacts and its effect on land, air, water and other organism and ecosystem of the island. The social-cultural impacts that affect local communities, social structure and cultures as well as economic impacts categorised as direct, indirect or induced. These requirements to be measured,

monitored and evaluated for continual improvement of the sustainability of the tourism industry in Mauritius.

The number of tourist arrivals for the year 2019 was 1,383,488, earning Rs 63.1 billion. Tourism is a pillar of the Mauritian economy, accounting for 23.9% of GDP. Employment data for the tourism sector as obtained from the Survey of Employment and Earnings relate to employment in food service, hotels and travel and other services establishments with 10 or more workers. In 2019, employment in these establishments reached 31,239. Tourism generated a contribution to GDP of Rs 38.7 billion, or 9.2% of GDP in 2018. The tourism industry directly employed 75,934 persons (or 13.2% of total employment). Tourists generated Rs 7.1 billion in revenue from taxes on products.

In 2019, the Rodriguan tourism industry was thriving, and the island welcomed nearly 78,000 tourists, almost double of its population size, and had 220 registered tourism enterprises with the Rodrigues Tourism Office. The symbiosis between the tourism sector and the other economic pillars of the Rodriguan society, such as agriculture and fishing, were highly visible and encouraged by the local authorities. (Rodrigues Island – Driving Green Innovation in the Tourism Sector during the COVID-19 pandemic | UNDP in Mauritius & Seychelles).

Tourism is a major sector of the economy for Mauritius and Rodrigues (Seetanah et al. 2015), and even thought to be the leading economic sector for not just Rodrigues, but Mauritius too. and whilst much of it in Mauritius has been beach tourism, this is less so that case in Rodrigues. Visitors are also increasingly searching for an authentic experience and discovery of nature. Our environment is indeed one of our major assets and latest observations point towards a severe degradation of our coastal zones as well as increasing threats due to climate change. (AHRIM-Annual-Report-2018-19-spread-final.pdf). Observations from the annual Survey of Inbound Tourism point towards less favourable ratings for Mauritius on the environment aspect. The results of the last three years mention a perceived degradation of the environment especially with a drastic drop in “Excellent” ratings under the different indicators. In 2015, 41% of visitors rated the State of our Environment as Excellent. In fact, latest observations from the annual Survey of Inbound Tourism point towards less favourable ratings for Mauritius on the environment aspect. The results of the last three years mention a perceived degradation of the environment especially with a drastic drop in “Excellent” ratings under the different indicators. In 2015, 41% of visitors rated the State of our Environment as Excellent. Indeed, the state of cleanliness of the country has seriously deteriorated over the years and national cleaning initiatives do not always converge. Local fully integrated initiatives will have to be encouraged and local communities empowered. Basic performance like cleanliness, aesthetic, and freshness will have to be constantly sought after and tourist areas and attractions need special attention.

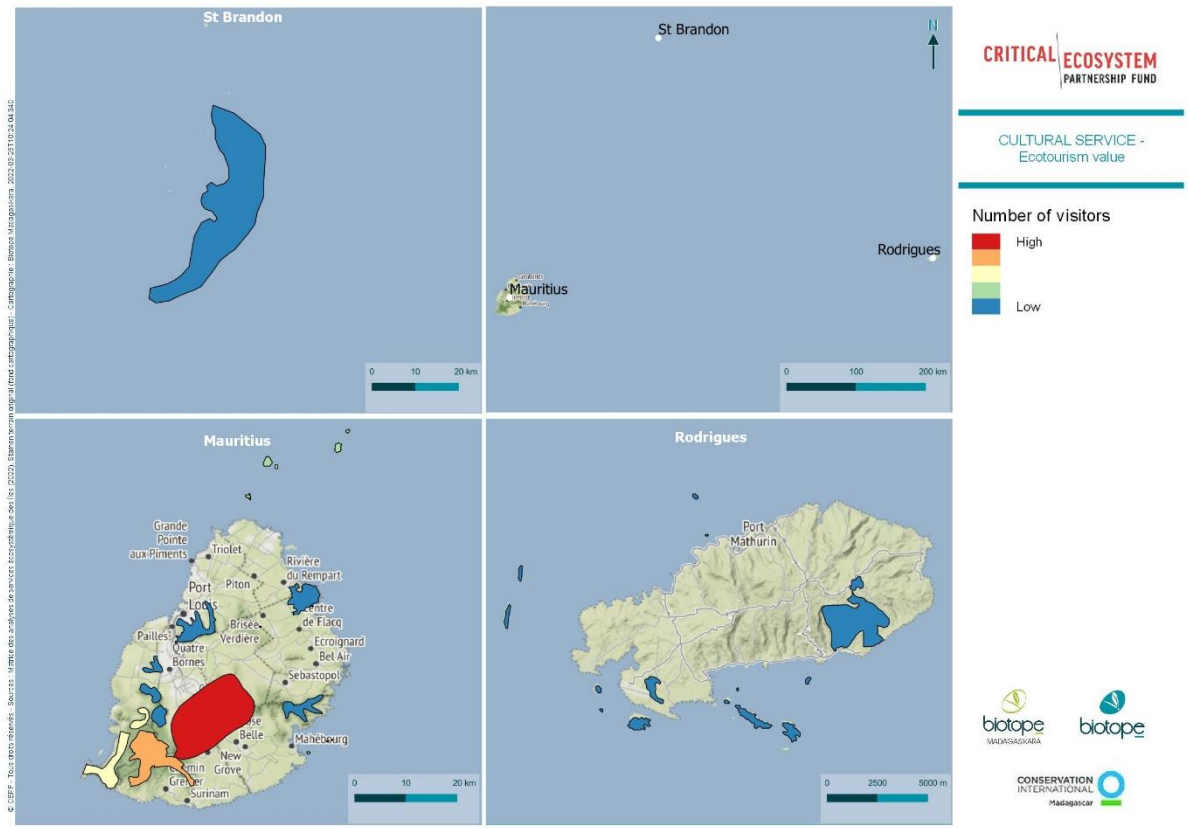
In addition to the above problems, Mauritius is undergoing rapid loss of habitat, increasing proportion of concrete, and declining SDG 15 trend.

All KBAs are either completely or else to some extent open to visitors. They have beautiful landscapes, unique wildlife and offer immense, and often untapped, ecotourism potential. The KBAs have functional ecotourism projects, but there is room for more projects, and more genuine ecotourism projects.

Annual visitor numbers pre-Covid-19 were used to assess the relative importance of KBAs in the Republic of Mauritius for ecotourism. Most KBAs received over 100,000 visitors per year pre-pandemic, giving them the highest relative importance for ecotourism. One level down from the majority of the KBAs were Tamarind Falls / Mount Simonet /Cabinet Nature Reserve, probably due to difficulties to access, danger and private ownership of parts of the KBA. Grande Montagne KBA in Rodrigues did not receive a high number of visitors either, since the ecotourism project there is recent.

Mondrain - Magenta - Trois Mamelles -Mont du Rempart KBA and Cargados Carajos Shoals KBA unsurprisingly received the lowest numbers of visitors, as the former is a privately owned site where access is restricted, and the latter is an extremely remote site that has not been promoted widely for ecotourism.

Figure 26 : Map showing the importance of KBAs for ecotourism



3.3.8 Multicriteria analysis: Ranking of KBAs

After aggregation of all the data and calculation of the multicriteria analysis, we obtain the classification of the KBAs as presented in the table below. The relative importance of each KBA for each ecosystem service was assessed on the basis of expert opinion, on a scale from 0 (absent) to 4 (very high). This was not done for ecotourism, where data on visitor number were available for all KBAs and were used instead.

Table 21 : Results from the methodology KBA+ for Mauritius

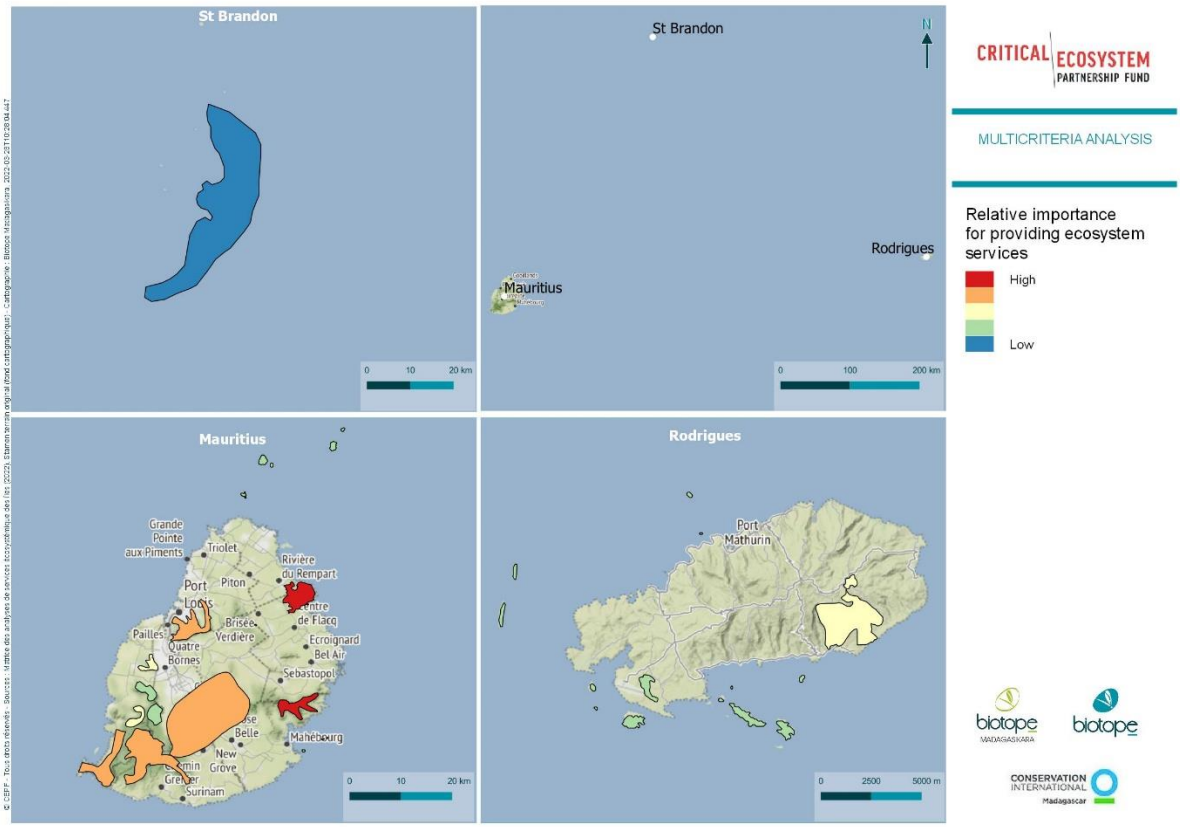
KBA Name	PROVISIONING								REGULATION AND MAINTENANCE				CULTURAL		Multi criteria analysis - Total	Rank
	Commercial fisheries		Water for domestic use		Water for irrigation		Water for hydropower		Cyclone protection		Flood protection		Ecotourism			
	Yes/ No (0/1)	Rel imp	Yes/ No (0/1)	Rel imp	Yes/ No (0 /1)	Rel imp	Yes/ No (0/1)	Rel imp	Yes/ No (0/1)	Rel imp	Yes/ No (0/1)	Rel imp	Yes/ No (0/1)	No. of visitors		
Cargados Carajos Shoals	1	4	0	0	0	0	0	0	0	0	0	0	1	300	0.200	16
Bambou Mountain Range	0	0	1	4	1	3	1	4	1	4	1	4	1	100,000	0.655	1
Chamarel - Le Morne	0	0	1	3	1	2	0	0	1	2	1	4	1	300,000	0.503	5
Tamarind Falls / Mount Simonet / Cabinet Nature Reserve	0	0	0	0	1	3	1	4	0	0	1	4	1	50,000	0.290	11
Relict Forests of the Central Plateau	0	0	1	4	1	4	0	0	0	0	1	4	1	500,000	0.550	2
Rodrigues' Islets	1	3	0	0	0	0	0	0	1	3	0	0	1	25,000	0.308	10
Mauritius Northern Islets	1	2	0	0	0	0	0	0	1	2	0	0	1	200,000	0.260	13
Mauritius South-Eastern Islets	1	3	0	0	0	0	0	0	0	4	0	0	1	150,000	0.395	6
Le Pouce - Anse Courtois - Pieter Both - Longue Mountain	0	0	0	4	1	3	1	2	0	0	1	4	1	100,000	0.280	12
Mondrain - Magenta - Trois Mamelles - Mont du Rempart	0	0	0	0	1	3	0	0	0	0	1	4	1	1,000	0.225	14
Corps de Garde Mountain	0	0	1	2	1	4	0	0	0	0	1	4	1	60,000	0.343	9
Black River Gorges National Park and surrounding areas	0	0	1	4	1	4	0	0	0	0	1	4	1	400,000	0.520	4
Plaine Corail	0	0	1	2	0	0	0	0	1	2	1	1	1	25,000	0.220	15
Plaine des Roches - Bras d'Eau	0	0	1	3	1	4	0	0	1	3	1	4	1	80,000	0.537	3
Pont Bon Dieu	0	0	0	0	0	0	1	1	0	0	1	4	1	15,000	0.167	17
South Slopes of Grande Montagne	0	0	1	3	1	3	0	0	1	2	1	2	1	5,000	0.364	7
Yemen-Takamaka	0	0	1	1	1	3	0	0	0	0	1	4	1	300,000	0.353	8

The final ranking is presented in the table and figure below.

Table 22 : KBAs ranked by multianalysis criteria

Code	KBA	Multicriteria score
MUS-2	Bambou Mountain Range	0.655
MUS-5	Relict Forests of the Central Plateau	0.550
MUS-14	Plaine des Roches - Bras d'Eau	0.537
MUS-12	Black River Gorges National Park and surrounding areas	0.520
MUS-3	Chamarel - Le Morne	0.503
MUS-8	Mauritius South-Eastern Islets	0.395
MUS-16	South Slopes of Grande Montagne	0.364
MUS-17	Yemen-Takamaka	0.353
MUS-11	Corps de Garde Mountain	0.343
MUS-6	Rodrigues' Islets	0.308
MUS-4	Tamarind Falls / Mount Simonet / Cabinet Nature Reserve	0.290
MUS-9	Le Pouce - Anse Courtois - Pieter Both - Longue Mountain	0.280
MUS-7	Mauritius Northern Islets	0.260
MUS-10	Mondrain - Magenta - Trois Mamelles - Mont du Rempart	0.225
MUS-13	Plaine Corail	0.220
MUS-1	Cargados Carajos Shoals	0.200
MUS-15	Pont Bon Dieu	0.167

Figure 27 : Relative importance of KBAs for multiple ecosystem services



4 Seychelles

Seychelles had a population of 97,023 inhabitants in 2018, i.e. an average population density of 213 inhabitants/km², one of the lowest in the South-West Indian Ocean zone after Madagascar. The population is increasing by 1.23% per year, which corresponds to a relatively low demographic growth. The GDP of Seychelles increased by 4.5% in 2016 and by 3.6% in 2018, even though it is generally low. Indeed, even if economic growth is strong, the country is indebted. Its HDI is 0.801/1 in 2018, which is equivalent to that of developed countries.

The country is a wealthy country in the overall African context, and tourism is one of the main economic activities, supporting nearly 30% of the local population. In 2017, no less than 349,000 people visited the Seychelles, more than 3 times the national population, and luxury tourism continues to grow, promoting environmentally friendly tourism. A second key economic sector in Seychelles is the fishing industry, which accounts for between 11 and 19% of formal employment. Victoria Harbour in Seychelles is the main tuna fishery in the Indian Ocean, accounting for 26% of the total tuna catch. Seychelles' oil and gas potential is being explored. Seychelles has limited agricultural production, accounting for only 2.2% of GDP, and imports almost all of its raw materials. The country is therefore heavily dependent on world trade, linked to the import of oil on which the country depends. Following a major economic crisis in 2008, the country adopted a strict economic policy in order to reduce its debts while developing the private sector (CEPF, 2014 ; PopulationData, 2020).

4.1 Key Biodiversity Areas

In the 2014 CEPF Ecosystem Profile, a study was conducted in order to identify Key Biodiversity Areas in Seychelles. A total of 57 KBAs was identified. The terrestrial KBA sites of high biodiversity value cover 27,093.5 ha, which represents 59.5 percent of the total land area of Seychelles. The marine sites cover more than 124,000 ha (measurement for a few marine areas was unavailable).

In terms of terrestrial biodiversity, the most important sites are found on the granitic islands (Mahé, Praslin and Silhouette), where the higher elevation has created favourable conditions for a diversity of habitats. The mountainous areas host a large diversity of plants, including a large number of endemics, and are of very high importance for water provision and erosion prevention.

The Table 8 provides the complete list of KBAs and the map from Figure 22 identifies the KBAs.

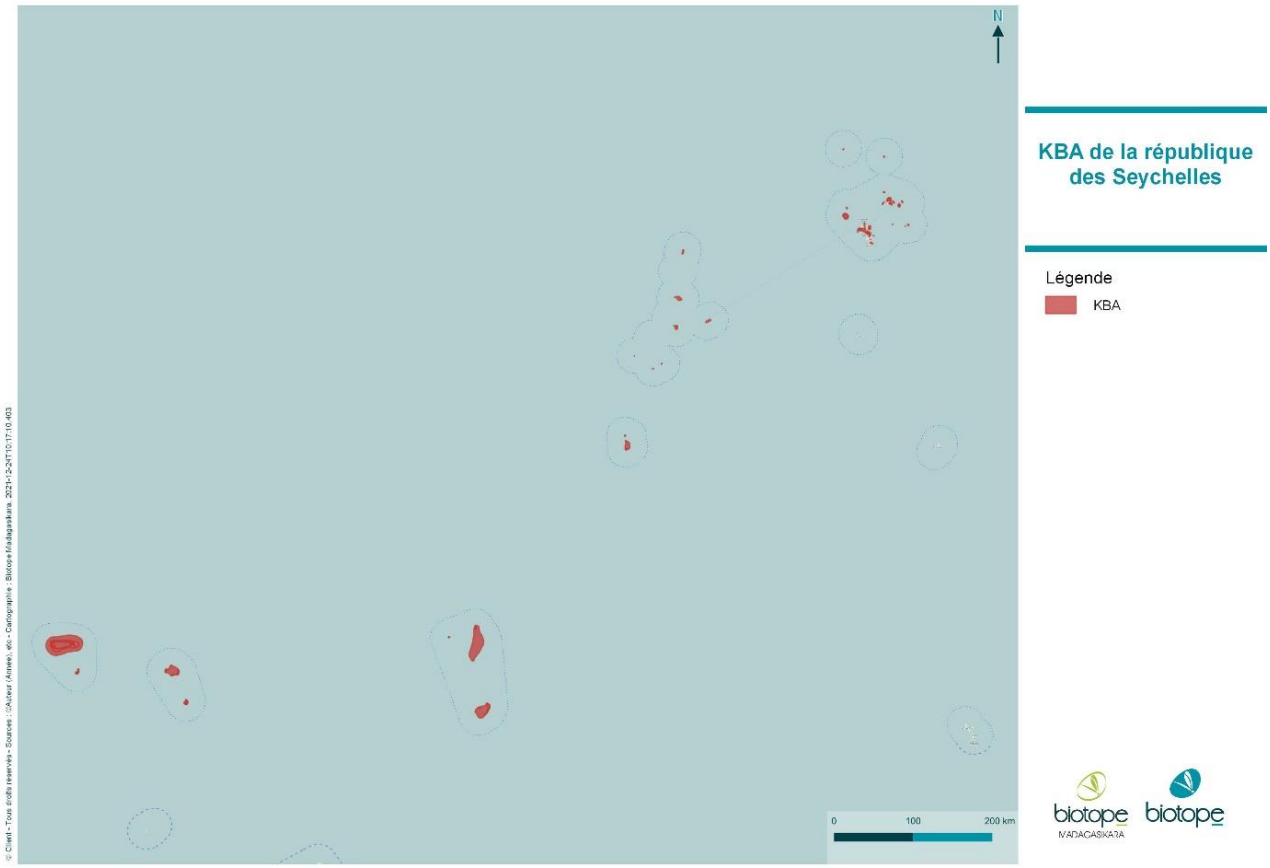
Table 23: List of KBAs in Seychelles

KBA ID#	ZCB (nom Francais)	KBA (English name)
SYC-1	Anse Major / Anse Jasmin (partie marine du MSNP)	Anse Major / Anse Jasmin (marine area of MSNP)
SYC-2	Anse Source d'Argent-Anse Marron	Anse Source d'Argent-Anse Marron
SYC-3	Astove	Astove
SYC-4	Bancs Africains	African Banks
SYC-5	Cosmolédo	Cosmoledo
SYC-6	Farquhar - Ile du sud et îlots	Farquhar - South Island and islets
SYC-7	Fond Azore (versants sud) à Anse Bois de Rose	Fond Azore southern slopes to Anse Bois de Rose
SYC-8	Fond Diable et Pointe Joséphine	Fond Diable and Pointe Joséphine
SYC-9	Fond Ferdinand	Fond Ferdinand
SYC-10	Forêt de l'Amitié	L'Amitié Forest

KBA ID#	ZCB (nom Francais)	KBA (English name)
SYC-11	Forêts sèches de Montagne Corail-Collines du Sud	Montagne Corail-Collines du Sud dry forests
SYC-12	Grand Anse-Petite Anse-Fond Piment	Grand Anse-Petite Anse-Fond Piment
SYC-13	Grand Police (zones humides)	Grand Police wetlands
SYC-14	Ile Assomption	Assomption Island
SYC-15	Ile aux Vaches (Bird Island)	Bird Island (Ile aux Vaches)
SYC-16	Ile Conception	Conception Island
SYC-17	Ile Cousine	Cousine Island
SYC-18	Ile Curieuse	Curieuse Island
SYC-19	Ile D'Arros et Atoll Saint-Joseph	D'Arros Island and Saint Joseph Atoll
SYC-20	Ile Denis	Denis Island
SYC-21	Ile Desnoeufs	Desnoeufs Island
SYC-22	Ile Desroches - récifs environnants	Desroches Island - surrounding reefs
SYC-23	Ile du Nord (North Island)	North Island (Ile du Nord)
SYC-24	Ile et Bancs de Providence	Providence Island and Bank
SYC-25	Ile et Lagon d'Alphonse	Alphonse Island and Lagoon
SYC-26	Ile Félicité	Félicité Island
SYC-27	Ile Frégate	Frégate Island
SYC-28	Ile Marie-Louise	Marie-Louise Island
SYC-29	Ile Sainte-Anne	Sainte-Anne Island
SYC-30	Ile Saint-Pierre	Saint-Pierre Island
SYC-31	Iles Etoile et Boudeuse	Etoile and Boudeuse Islands
SYC-32	Iles Saint-François et Bijoutier	Saint-François and Bijoutier Islands
SYC-33	Ilot Frégate	Ilot Frégate
SYC-34	Lagon de Poivre et récifs environnants	Poivre Lagoon and surrounding reefs
SYC-35	Mont Signal	Mont Signal
SYC-36	Montagne Brûlée-Piton de l'Eboulis	Montagne Brûlée-Piton de l'Eboulis
SYC-37	Montagne Glacis - When she comes	Montagne Glacis - When she comes
SYC-38	Montagne Planneau (Grand Bois-Varigault-Cascade)	Montagne Planneau (Grand Bois-Varigault-Cascade)
SYC-39	Nid d'Aigle (crêtes et versants Est)	Nid d'Aigle (ridge and eastern slopes)
SYC-40	Parc National de l'Ile aux récifs	Recif Island National Park
SYC-41	Parc National de Praslin	Praslin National Park

KBA ID#	ZCB (nom Francais)	KBA (English name)
SYC-42	Parc National de Silhouette	Silhouette National Park
SYC-43	Parc National du Morne Seychellois	Morne Seychellois National Park
SYC-44	Parc National Marin de Cap Ternay / Baie Ternay	Cap Ternay / Baie Ternay Marine National Park
SYC-45	Parc National Marin de l'Ile Cocos	Ile Cocos Marine National Park
SYC-46	Parc National Marin de l'Ile Curieuse	Curieuse Island Marine National Park
SYC-47	Parc National Marin de Port Launay et zone humides côtières	Port Launay Marine National Park and coastal wetlands
SYC-48	Parc National Marin de Sainte-Anne (PNMSA)	Sainte-Anne Marine National Park (SAMNP)
SYC-49	Parc National Marin de Silhouette	Silhouette Marine National Park
SYC-50	Réserve Spéciale d'Aldabra	Aldabra Special Reserve
SYC-51	Reserve Spéciale de l'Ile Aride	Aride Island Special Reserve
SYC-52	Réserve Spéciale de l'Ile Cousin	Cousin Island Special Reserve
SYC-53	Réserve Spéciale de La Veuve	La Veuve Special Reserve
SYC-54	Rivière Kerlan	Kerlan River
SYC-55	Rochers d'Anse Petite Cour	Anse Petite Cour Boulders
SYC-56	Val d'Endor	Val d'Endor
SYC-57	Zone de La Misère-Dauban : La Misère	La Misère-Dauban area: La Misère

Figure 28: Map of KBAs in Seychelles



Detailed maps of KBAs in Seychelles are available in Appendix 3.

For this update, no modifications have been made regarding KBAs.

4.2 Ecosystem Services Identification

4.2.1 Materials and method

The KBA+ approach was developed by Conservation International and CEPF and described in Neugarten *et al.* (2014). The general guidelines developed were used. These guidelines include, firstly, the listing of ecosystem services, their description, the evaluation of data needed and sources to be consulted. Secondly, a binary evaluation was made for each ecosystem service and each KBA, in order to select the main ecosystem services for the set of KBAs. Thirdly, a quantitative or semi-quantitative evaluation was done using the data sources selected in order to rank KBAs by importance for the various ecosystem services, individually and generally using a multicriteria approach. For each Ecosystem Service in each KBA, a semi-quantitative rating, inspired from TNC (2022) with 4 levels: 1=Low, 2=Moderate, 3=High, and 4=Very high, was applied.

It is essential to understand that the importance of the ES is directly linked to the amount of people that are benefiting from it. This can be **human populations living into or within a certain radius of the KBA, or in some cases the population of Seychelles as a whole.** Because the number of inhabitants in small islands (both inner and outer islands) is tiny (10-30), this is why most ES ratings for these sites will be low. In islands where no population lives at all, some ES may even be nil, except when some ES are still provided through tourism visits. However, 10 or 50 inhabitants over 100,000 does not mean no inhabitants at all. In small islands or outer islands, where only a very few inhabitants are present, we still provided a minimum rating of '1', taking into account the vulnerability of this human presence, although it

represents only a tiny percentage of the Seychelles population, and hence a minimal ES to Seychelles population.

There has been no KBA inventory update since 2014; hence the data used corresponds to the list of KBAs from Senterre *et al.* (2013) that appears in the last CEPF Ecosystem Profile published in 2014. It would be good for this list to be updated. For example, following the invasion of Conception Island by Black rats in 2016, this island no longer holds a population of the Vulnerable Seychelles white-eye, that was its main criteria to be identified as an IBA (Rocamora & Skerrett, 2001), and therefore as a KBA. On the other hand, Grande Soeur Island, where this species was translocated in 2018, hold now a population of over 100 birds, that represent 20% of the species global population, and verifies now the IBA & KBA criteria. Unless beneficiaries are specifically mentioned, beneficiaries are the communities living in the vicinity of the KBAs, and where relevant all the population of Seychelles.

For marine KBAs, a report from TNC was used for evaluating the importance of priority ecosystem services. An extract from this study is presented below.

Figure 29 : Relative ranking of ES values among Seychelles Marine Protected Areas for Recreation and Tourism, Artisanal Fisheries, Coastal Protection and Blue Carbon using Jenks Natural Breaks classification. (TNC, 2022; table p.58).

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Table 16. Relative ranking of ES values among Seychelles Marine Protected Areas for Recreation and Tourism, Artisanal Fisheries, Coastal Protection and Blue Carbon using Jenks Natural Breaks classification.

		Recreation and Tourism			Artisanal Fisheries				Coastal Protection	Blue Carbon	
	Protected Area	On Reef	Beaches	Bird Watching	VMS Fleet (% of total)	VMS Fleet (per hectare)	Outboard (% of total)	Outboard (per hectare)	Coastal Protection	Mangrove	Seagrass
MSP Marine Protection Areas	Aldabra Group (Marine) National Park	L	L	M	L	L	NA	NA	L	NA	L
	Alphonse Group (Marine) AONB	VH	M	H	M	M	NA	NA	M	L	M
	Amirantes (Marine) to Fortune Bank (Marine) AONB	M	L	M	VH	M	VH	L	M	M	VH
	Amirantes South (Marine) National Park	L	L	L	H	M	NA	NA	L	NA	VH
	Bird Island (Ile aux Vaches) (Marine) National Park	M	M	VH	H	VH	NA	NA	L	NA	M
	Cosmoledo and Astove Archipelago (Marine) AONB	VH	L	M	L	L	NA	NA	L	H	M
	D'Arros Atoll (Marine) National Park	M	L	M	L	VH	NA	NA	L	NA	L
	D'Arros to Poivre Atolls (Marine) National Park	L	NA	L	M	M	NA	NA	NA	NA	H
	Denis Island (Marine) AONB	M	H	L	M	VH	NA	NA	L	NA	L
	Desroches Atoll (Marine) AONB	VH	H	M	M	M	NA	NA	M	NA	M
	Farquhar Archipelago (Marine) AONB	L	NA	M	H	M	NA	NA	L	NA	M
	Farquhar Atoll (Marine) AONB	L	L	L	M	M	NA	NA	L	M	M
	Poivre Atoll (Marine) AONB	L	L	M	M	VH	NA	NA	L	L	L
Existing Marine Protection Areas	African Banks Protected Area	L	L	L	L	VH	NA	NA	L	NA	L
	Aldabra Special Reserve	L	NA	H	L	L	NA	NA	L	VH	H
	Aride Special Reserve	L	L	M	L	H	H	VH	L	NA	L
	Baie Ternay Marine National Park	H	M	L	L	M	L	H	L	NA	L
	Cousin Special Reserve	L	M	M	L	H	M	VH	L	NA	L
	Curieuse Marine National Park	H	VH	L	L	M	H	H	H	L	L
	Ile Cocos Ile La Fouche Ilot Platte Protected Area	H	M	L	L	H	M	VH	L	NA	L
	Mahé (Anse Faure-Fairy Land) Shell Reserve	L	VH	L	L	L	L	M	VH	NA	L
	Port Launay Marine National Park	M	VH	L	L	H	M	H	H	L	L
	Silhouette Marine National Park	VH	VH	L	L	H	H	M	L	NA	M
	Ste Anne Marine National Park	H	VH	L	L	M	H	H	H	NA	L

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4.2.2 Prioritization of ecosystem services

Here we describe the list of ecosystem services that are relevant for the KBAs of Seychelles. This list was derived from a table provided by CI, modified based on expert opinion. We discuss the importance of beneficiary communities, their vulnerability to climate change, and indicators for the spatial evaluation of the service (distribution and quality of the providing ecosystems).

Table 24 : List of ecosystem services

Section	Division	Group	Ecosytem Service
Provisioning	Nutrition	Biomass	Commercial fisheries
		Water	Water for domestic use
	Materials	Biomass	Forest products
			Medicine
Regulation and maintenance	Mediation of waste, toxic substances and other nuisances	Mediation through ecosystems	Regulation of water quality for household use, irrigation and hydropower
	Flow mediation	Protection against extreme weather events	Flood protection
			Cyclone protection
	Maintenance of physical, chemical and biological conditions	Life cycle maintenance, habitat and gene pool protection	Sustaining habitats and genetic diversity
			Species conservation value
		Regulation of atmospheric composition and climate	Local climate regulation
			Global climate regulation
Cultural	Physical and intellectual interactions with ecosystems and the land and seascape	Physical and experiential interactions	Ecotourism
		Intellectual and representational interactions	Cultural and educational value

From the list of ecosystem services in Table 24, a list of priority ecosystem services was selected, by a team of experts, by applying the following criteria:

- Contribution of the service to the resilience of local populations to climate change,
- Availability of data.

Given the relative lack of information about the values of ecosystem services in the Seychelles, the most important criterion was availability of data. For ecosystem services with available data, the presence/absence of each ecosystem service at each KBA was assessed by the experts, in order to select those that make the greatest contribution to climate resilience for the population of the Seychelles. The draft list of priority ecosystem services and the draft weightings for each were presented at a stakeholder consultation workshop held at the University of Seychelles on 9 March 2022, where they were validated by stakeholders.

The priority ecosystem services selected were (1) commercial fisheries, (2) water for domestic use, (3) forest products, (4) medicines, (5) local climate regulation, (6) cyclone protection, (7) flood protection, (8) sustaining habitats and genetic diversity, (9) ecotourism and (10) cultural and educational value.

4.2.3 Importance according to Ecosystem-based Adaptation

A multicriteria analysis was used to assess of the relative importance of each KBA for provision of ecosystem services that contribute to local populations' resilience to climate change, and thus to identify priority KBAs for investments in Ecosystem-based Adaptation. To calculate a weighted mean of the ratings for the 10 prioritized ecosystem services, we assigned a semi-quantitative rating to each ecosystem service at each KBA, with the following levels: 0=Absent, 1=Low, 2=Moderate, 3=High, and 4=Very high (adapted from TNC, 2022). Provisional ratings were assigned by the expert team, following a semi-quantitative methodology, as described in the following section; the results were then validated during the stakeholder consultation meeting.

The population of Seychelles relies fundamentally on locally obtained freshwater (for drinking and other basic needs), on imports for most food items (except fish), manufactured products and materials, and on tourism and fishing industries for cash to sustain those imports. Therefore, we gave more weight (4) for ecosystem services provisioning food (ES 1) and water (ES 2). We also considered coastal protection (ES 6) and flooding protection (ES 5) as essential ES with a weight of 4. KBAs that are more extensively forested and that are located on the three main populated islands receive the highest scores in the multicriteria analysis. Indeed, forest ecosystems provide water, forest products, soil erosion and flooding reduction, and carbon stocks; they sustain the local climate (rainfall and temperature), the tourism (greenery of Seychelles) and they represent an important cultural value. Although the Seychelles have one of the highest percentages of land area under legal protection (47%), only 17% of the forested land of the Inner Islands (where the population needing these ES is present) is included in these protected areas. This emphasizes the extreme vulnerability of the Seychelles to climate changes, and the need to account for more aspects than biodiversity for land protection and land use management.

Table 25 : Ecosystem services scoring for multi-criteria analysis

Ecosystem Service	Weight
PROVISIONING	**0.375**
1. Commercial fisheries	0.125
2. Water for domestic use	0.125
3. Forest products	0.09375
4. Medicines	0.03125
REGULATION & MAINTENANCE	**0.46875**
5. Local climate regulation	0.09375
6. Cyclone protection	0.125
7. Flood protection	0.125
8. Sustaining habitats and genetic diversity	0.125
CULTURAL	**0.15625**
9. Ecotourism	0.09375
10. Cultural and educational value	0.0625
TOTAL	**1**

4.3 Priority Ecosystem Services

Based on the data available in Seychelles, we evaluated the main ecosystem services that are priorities for the potential resilience of local populations to climate change, and the relative contribution, or importance, of each KBA in Seychelles for each of those services. First and foremost, it is important to say that although a substantial amount of work has been done in Seychelles for the marine environment (TNC, 2022), virtually nothing has been done on the terrestrial side. Therefore, with limited amount of time allocated to this study, there is a serious risk that what follows below includes misleading guesstimates.

Unless beneficiaries are specifically mentioned, beneficiaries are the communities living near the KBAs and where relevant all the population of Seychelles.

4.3.1 Provisioning: Commercial fisheries

In Seychelles, all marine KBAs provide food for humans, at least indirectly in the case of protected KBAs. For terrestrial KBAs, food provision is only anecdotic (e.g. jackfruit).

The unfolding climatic and environmental crisis will certainly affect the fishing industry through the cost of fuel. Therefore, in terms of resilience to climate change, the distance from fishing areas to ports and fish markets is also a factor to consider.

For Seychelles, a recent study by The Nature Conservancy (TNC) (TNC, 2022) provided more relevant and more accurate data. TNC ranked Seychelles marine PAs (corresponding largely to the KBAs listed by CI for the region) based on a "Relative Selectivity Index" (RSI: TNC 2021, page 10), developed "by comparing percent of fishing effort to the percent availability of seafloor habitats (Thomas & Taylor, 1990)". TNC (2021) then "applied these RSI values to the composition of habitats within Seychelles' marine protected areas". In this way, they "evaluated MPAs based on their habitat composition, weighted by how preferentially these habitats were used by artisanal fishers, whether fishing occurred within the MPA boundaries or not". They evaluated "separately for mid-sized vessels (including whalers and schooners) equipped with VMS-tracking technology (Robinson et al., 2020) and smaller vessels with outboard engines that fish relatively near the inner islands on the Mahé Plateau".

The synthetic data describing these indicators for KBAs of Seychelles are provided in the TNC report (2021: see Table 4 on page 23 and Table 16 on page 58). These ratings are summarized in Figure 3 above. For a few areas where regular artisanal fishing (sometimes illegally in protected areas) is known to occur (e.g. reefs around Frégate Island), we attributed a minimum semi-quantitative rating of '1'; while also taking into account the indirect positive effects of protected areas on fish caught in adjacent areas.

One of the problems we faced is the heterogeneity of the KBA inventory in Seychelles. Some small island KBAs are strictly terrestrial (with beaches but excluding reefs; e.g. Ile du Nord, Conception), while others include a marine area (e.g. Aldabra), and sometimes terrestrial island KBAs are surrounded by a marine KBA, most often a protected area (e.g. Ste Anne, Silhouette, Curieuse). Some harmonisation of the boundaries of KBAs will need to be done at some point,

CEPF focuses on terrestrial and coastal areas; it does not support work in off-shore marine ecosystems. However, in some cases, for the purposes of CEPF investment, fringing reefs, seagrass beds and other inshore marine ecosystems can be included within the boundaries of a priority site, up to a limit of 12 nautical miles from the shore.

Site boundaries determine the calculations of their ES ratings. Nevertheless, following CEPF guidance, we took into account fishing taking place in the immediate surroundings (coral reefs, tidal flats) of a terrestrial island KBA. This was done for example for Ile du Nord (a strictly terrestrial KBA), which surrounding (unprotected) reefs are one of the best fishing areas for Octopus in the Seychelles. We therefore attributed to Ile du Nord a rating of '2' for food provisioning (whereas taking into account only the official terrestrial boundary it should be '0').

As part of the Marine Special Planning programme, other strictly terrestrial island KBAs, such as Bird Island or Denis Island, are now surrounded by recently gazetted new MPAs (https://seymsp.com/outputs/phase-3/milestone-3-nomination-file/) which maps are available (https://seymsp.com/outputs/phase-3/milestone-3-gazetted-areas/); although regulations have not been published yet.

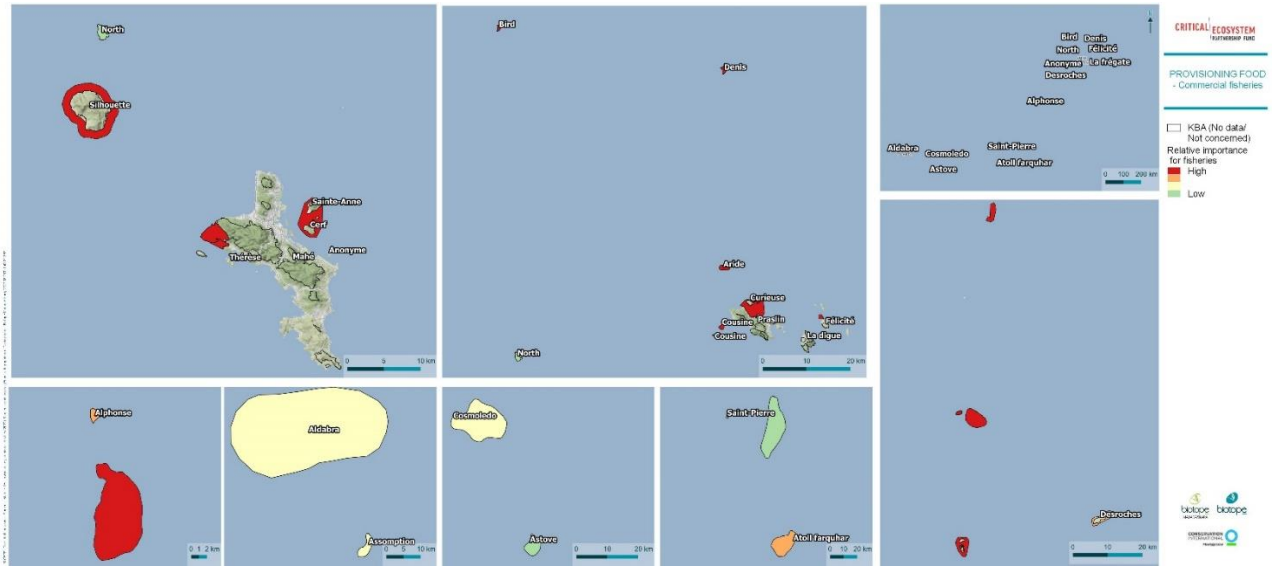
The ES of these marine protected areas have been evaluated by TNC in their report (TNC, 2022). Table 1 presents these values for these 13 new MPs and a dozen already existing MPAs (marine national parks, or marine parts of special reserves) already considered as KBAs since 2014.

As per the instructions received from CEPF, the new declared marine protected areas (MPAs) were not treated as marine KBAs, as these areas had not been assessed against the KBA criteria as it could not be assumed that marine KBAs overlapping with these MPAs would have coincident boundaries. From the 13 new MPAs concerned, one is not coastal and does not contain any island KBA, and some extend to much greater distances. However, the following nine new MPAs are well below 12 nm (c.22.2km) distance limit from KBA land, except for one for which less than 5% of the MPA falls outside 12 nautical miles from shores. Hence, when assessing terrestrial island KBAs included in these MPAs, we also took into account ecosystem services provided by coastal and inshore marine ecosystems of the following new MPAs:

- Bird Island (Ile aux Vaches) (Marine) National Park: contains KBA SYC-15 ; map page 2; max. distance from shore c. 12km.
- Denis Island (Marine) AONB: contains KBA SYC-20; map page 6; max. distance c.3km.
- D'Arros Atoll (Marine) National Park: contains KBA SYC-19; map. page 3; max. distance c.4km.

- Desroches Atoll (Marine) AONB: contains KBA SYC-22; map. page 7; max. distance c.18km.
- Poivre Atoll (Marine) AONB: contains KBA SYC-34; map. page 7; max. distance c.5km.
- Alphonse Group (Marine) AONB: contains KBA SYC-25 and KBA SYC-32; map. page 7; max. distance c.10km
- Farquhar Atoll (Marine) AONB: contains KBA SYC-6; map. page 8; max. distance c.15km.
- Amirantes South (Marine) National Park: contains KBA SYC-25, KBA SYC-32, KBA SYC-25 and KBA SYC-32: map. page 4; max. distance c.22km from land).
- Cosmoledo and Astove Archipelago (Marine) AONB: contains KBA SYC-5 and KBA SYC-3; map. page 9; max. distance c.30km; but over 95% of the MPA is within 12nm)

Figure 30 : Relative importance of KBAs in Seychelles for commercial fisheries



4.3.2 Provisioning: Water for domestic use

Considering that the large majority of the population is located on the three main islands of Mahé, Praslin and La Digue, only the KBAs of these islands are potentially relevant for the provision of water resources in the context of the climatic resilience for the people of Seychelles. Although water seems plentiful in those islands, it relies entirely on the quality of the tiny watershed areas found there, as opposed to continental areas with vast catchment areas. Therefore, and also considering the growing water consumption, it is clear that the population of Seychelles as well as its tourism industry will be increasingly vulnerable to water scarcity, especially if deforestation (due to urban development) or forest fires affects the water catchment areas. Another concern about La Digue (where groundwater is the main supply source: Futter & Dollar 2017: 3) is the high vulnerability of the limited freshwater table on this small island (c.1000ha), submitted to a risk of irreversible salinization in case of over-exploitation, and risks of pollution due to the absence or very limited grey water collection and treatment system on the plateau where most of the housing development is concentrated.

Considering the high relevance of this ecosystem service for climatic resilience, we calculated for each KBA the percentage of the total water catchment areas of Seychelles that is located within that KBA.

The data needed for this analysis include the list of GPS coordinates for all river abstraction barrages and a Digital Elevation Model (DEM). The former was provided by the Public Utility Corporation (PUC), and the latter was created by combining existing Lidar data for some islands (Senterre and Wagner, 2014) and JAXA/ALOS/AW3D30_V1_1 (Tadono et al., 2014) for other islands (e.g. Silhouette), thus producing a DEM covering the extent of the Inner Islands resampled with a 10 m resolution. Water catchment areas were then mapped using a R script based on TauDEM (Tarboton, 2013), delineating watersheds located upstream of the river abstractions.

The index proposed above describes better the relative importance of different KBAs to the provisioning of water. Nevertheless, it is largely insufficient as it does not account for contrasted rainfall from one site to another (from 1400 to 5000 mm/year), for slope and land cover (and thus runoff intensity), for flow accumulation, and for pollution and siltation sources (landslides and degraded land with bare soils). It also lacks data (not available) on the private in-stream abstractions and withdrawals (very common but undocumented) or on the catchment sites for irrigation purpose. A map of land cover types and ecosystems has been produced recently (Senterre et al., 2021) at 10 m resolution and for the whole Inner Islands, that should be used to improve this analysis, along with these other parameters. Rainfall data exist but are not available in a synthetic form such as a modeled raster of rainfall distribution over the main islands, and this serious gap should be addressed if we want to evaluate seriously the provisioning of water as an ecosystem service.

Based on our simplified analysis using Taudem (see above), we have mapped all water catchments of the 4 main islands. These islands represent a total land area of 15,367 ha for Mahé (ca. 80,000 inhabitants, 80%), 3758 ha for Praslin (ca. 8000 inhabitants, 8%), 1987 ha for Silhouette (ca. 200 inhabitants, 0.02%) and 982 ha for La Digue (ca. 3000 inhabitants, 3%). The area of watersheds that is used for water catchment (PUC barrages and withdrawal) corresponds to 3848 ha in total for these 4 islands (25% of these 4 islands): 3057 ha for Mahé (80% of total catchment area), 551 ha for Praslin (14%), 87 ha for Silhouette (2%) and 153 ha for La Digue (4%). Only 16 KBAs overlap with catchment areas, and out of these the three most important for water catchment account for 68% of the total catchment areas of the 4 islands: Morne Seychellois National Park (45%), Montagne Planneau (16%), and Praslin National Park (7%).

For all small islands with few inhabitants, we rated the provision of water provided from a water lens or even from rainfall (e.g. Aldabra), with a minimum of '1' because these tiny islander populations, although rotating, are highly vulnerable to climate change, and if rainfall decreases they will inevitably suffer, unless artificial energivore solutions are provided, through desalination and solar panel (hence the most natured-based solution will probably be to increase the surface of rainfall collection). This is something that we have not seen in the KBA+ approach, but we think it makes sense for all our small islands with small, but nevertheless important, human presence.

Figure 31 : Relative importance of KBAs in Seychelles for water for domestic use

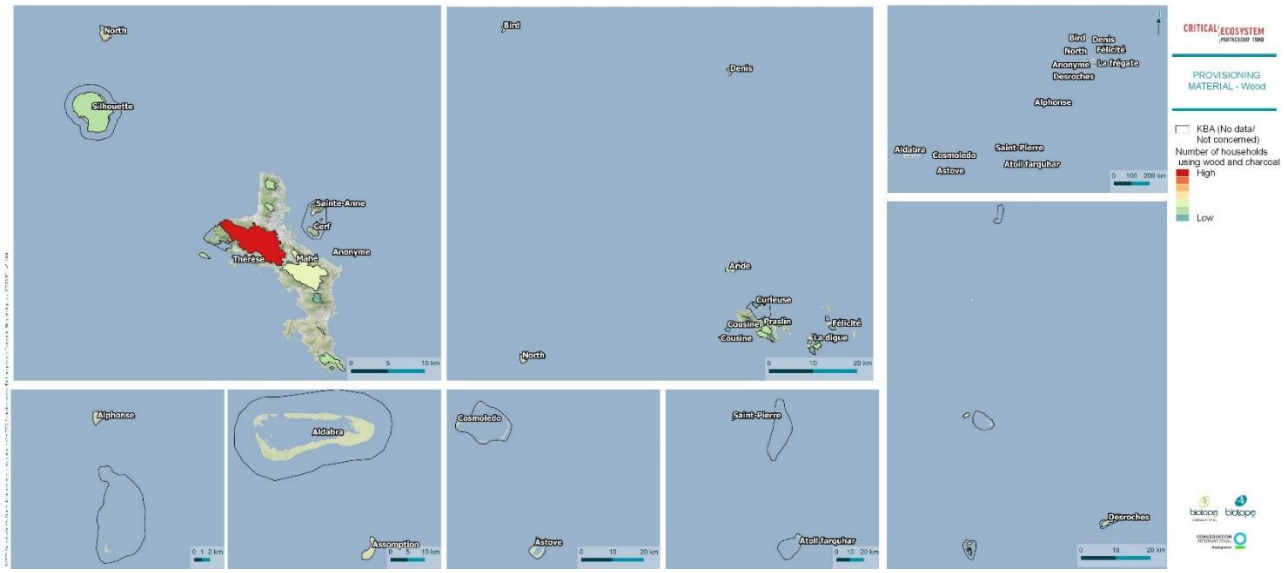
4.3.3 Provisioning: Forest products

Several KBAs do provide timber, such as the Morne Seychellois National Park, the area of Montagne Brûlée, and the Praslin National Park. Data on the volume of stocks, or on timber extractions, are not available, and much less so in terms of spatial data. Other forest products include *Lodoicea maldivica* (Coco-de-mer) nuts and palm leaves (representing different services), but data are limited or relevant only locally for a given KBA. Data on forest products cannot be synthesized because of the lack of spatial data on the aspect of timber resources. In

terms of climate change adaptability, it is clear that there will be a high risk on the prices of imported timber, which could potentially reinforce interest in local timber resources. But we also have no access to data on the needs in terms of timber (volume of imports). Currently, this ecosystem service remains limited considering the high cost of local extraction, compared to the cost of imported wood products. Nevertheless, local communities do occasionally enter forested KBAs (e.g. Morne Seychellois National Park) to collect some timber or some perches for their own use, although this is in principle not allowed, but this activity is very marginal. In future there is a possibility for a redevelopment of Cinnamon industry, this would mostly be relevant to buffer zones closer to roads, although some could possibly occur within the limits of the main KBAs. Some organisations (SIF, SNPA) managing nature reserves on Praslin and Curieuse, as well as some Praslin private owners derive significant income from the commercialisation of Coco-de-mer nuts.

Therefore, we evaluated this ecosystem service using a semi-quantitative scale and experts' guesstimates, later reviewed following exchanges with stakeholders. In addition, to account for the relative potential of KBAs for the production of forest products (especially timber), we have also used data provided by Senterre et al. (2021) for the map of "integrated land uses". We calculated for each KBA the cover of forestry land (named eco-buffer zone) relative to the total cover of forestry land of the Inner Islands. This was done in the same R script, using the KBA shapefile of CI, the integrated land use map and the land cover map of the Inner Islands. Note that some KBAs with known forestry plantations (of exotic species such as Mahogany), such as Montagne Brûlée, are in fact mostly located uphill of these plantations and there the extracted statistics might appear small or even null. Note also that several major KBAs of the Inner Islands have been discussed by Senterre et al. (2021) who propose new delineations, including for example the joining (green corridor) of Montagne Brûlée with Montagne Planneau.

Figure 32 : Relative importance of KBAs in Seychelles for forest products

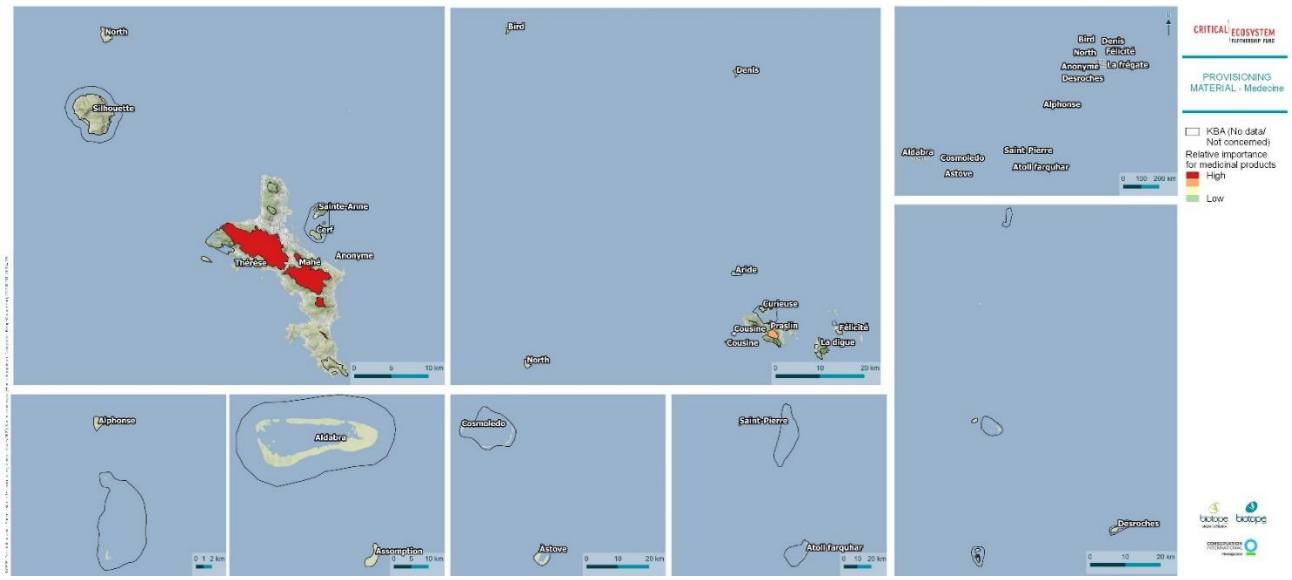


4.3.4 Provisioning: Medicines

This ecosystem service (ES) was not in the CI-Biotope table but is to some extent relevant to Seychelles. In Fischlin et al. (2007), this ES is placed within the Provisioning section, so we include it here although in fact it is arguably more a cultural service (the pharmacology of the species used being poorly known). The most popular medicinal plants that are being targeted by local communities for collection in (semi) natural ecosystems include *Psychotria pervillei* (Bwa koulev), *Craterispermum spp*. (Bwa dou), *Diospyros sechellensis* (Bwa sagai), *Aphloia theiformis subsp. sechellensis* (Bwa merl), *Brexia microcarpa* (Bwa kato), *Ochrosia oppositifolia* (Bwa susuri) and *Pittosporum senacia subsp. wrightii* (Bwa zoli ker).

Due to the very limited time available for this study, we only evaluated the KBAs semi-quantitatively based on expert knowledge.

Figure 33 : Relative importance of KBAs in Seychelles for medicines



4.3.5 Regulation and maintenance: Flood protection

Flooding have been occurring in Seychelles occasionally in the coastal plateau areas of the island of Mahé, rarely of Praslin and La Digue, due to the degree of urbanization (increased runoff and decreased infiltration), wetland reclamation, and to watershed deforestation.

We propose to evaluate the value of a KBA for flood protection by considering a semi-quantitative index based on expert knowledge of the area of catchment that is located upstream of the three large coastal plateaux mentioned above, and that is contained in the KBA, relative to the total area of that catchment. We also consider the relative size of wetlands contained in the KBA upstream of the coastal plateau, and other factors related to runoff such as land cover and slope.

Figure 34 : Relative importance of KBAs in Seychelles for flood protection

4.3.6 Regulation and maintenance: Cyclone protection

The potential cyclone surge protection is largely provided by marine and intertidal ecosystems, such as mangroves and nearshore plateau, combined with degree of exposure to swell and coastline protection.

These factors have been analysed by TNC (TNC, 2022: Table 16, page 58) using a complex approach. We simply use their results and introduce these for the list of KBAs discussed here. We simply use their results and introduce these for the list of KBAs discussed here. It is important to note that the area with the highest score for coastal protection is an area that is missing from the CI-Biotope KBA list, namely "Mahé (Anse Faure-Fairy Land) Shell Reserve". This ES can only be provided by coastal and marine habitats in KBAs, whereas the previous one is only provided by terrestrial habitats and land KBAs.

Figure 35 : Relative importance of KBAs in Seychelles for cyclone protection

4.3.7 Regulation and maintenance: Sustaining habitats & genetic diversity

Some KBAs contribute greatly to nature conservation due to their exceptional biological value. They provide, for example, suitable habitats for certain rare and threatened species, especially unique plants and animals that may be endemic forms only found in Seychelles; this includes KBAs such as Morne Seychellois National Park, Praslin National Park and Silhouette National Park. KBAs can represent a reservoir of species with healthy, genetically diverse populations able to repopulate areas where they are being too heavily exploited or from where they have disappeared. Some species that may not have an economic value right now could become a resource in future (e.g. plants that could provide medicines, or aromas to produce perfumes, ornamental species, etc.). KBAs also contribute to key life cycle biological processes. These include large KBAs such as Aldabra atoll, or Cosmoledo atoll, but also tiny islands like Aride, Cousin or Bird that host wildlife concentrations (seabirds, marine turtles) of international importance and contribute significantly to the functioning of the entire ocean ecosystem.

Which KBAs contribute the most to regulating natural processes in general, life cycles, the environment and habitats, and genetic diversity? The complexity of this question, or this so-called ecosystem service, is so vast that answers can only be simplistic and partial. Nevertheless, this is to some degree the case for most of the other ecosystem services too, and therefore we will propose such a simplistic answer, but not without stressing the fact that it is largely so.

We proposed to use an indicator that is as complementary as possible to the traditional KBA methodology (focused on the species conservation value) to identify the more important KBAs for sustaining habitats and genetic diversity. Considering that the larger the KBA the more likely it is to have a high number of species and habitats, we gave a first semi-quantitative index to each KBA according to the order of magnitude of its area (1: < 100 ha, 2: 100-999 ha; 3; 1000-4999 ha; 4: >5000 ha). We then topped up the score by one or two for KBAs with high numbers of globally threatened species of flora and fauna (terrestrial and marine) or with wildlife concentrations of international importance. This attempts to rank the KBA according to their importance for biological processes. This ES is particularly important to valorise KBAs with a high biological value that contain rare and threatened species or wildlife concentrations of international importance, and that are important to the whole of the Seychelles population, and beyond.

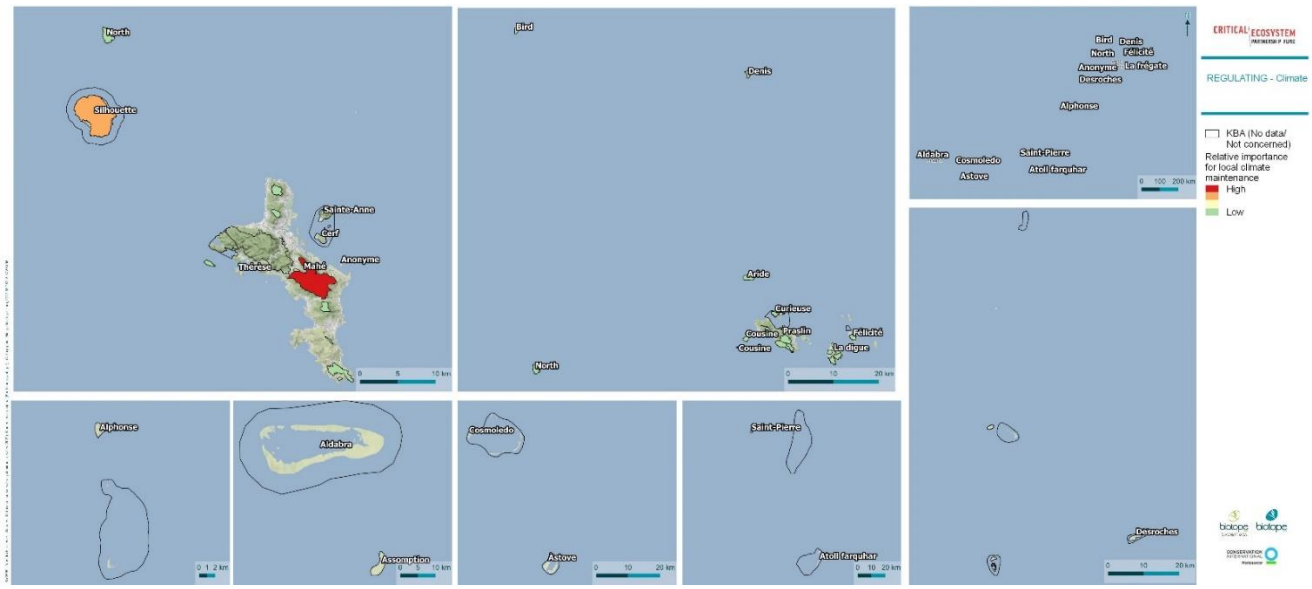
Figure 36 : Relative importance of KBAs in Seychelles for sustaining habitats and genes

4.3.8 Regulation and maintenance: Local climate regulation

In terms of climate changes, the most relevant aspect for the local communities of Seychelles, and their vulnerability and adaptability, is not so much related to global climate as it is to local climate. Indeed, for tropical environments, and especially small islands as Seychelles, the local climate is largely influenced by the local forest cover, as a keystone factor for water cycle and temperature regulation (Bunyard, 2014; Catling and Stroud, 2012; McAlpine et al., 2018; Oglesby et al., 2010; Shaw, 2003; Sheil, 2018; Sheil and Murdiyarso, 2009).

To evaluate the relative contributions of KBAs to this ecosystem service, we evaluated the forest cover in a KBA relative to the total forest cover of the Inner Islands. For the Outer Islands, we have no or little data. Aldabra, that occupies about one third of the total area of Seychelles, is covered in its majority by low dry forest (which physiognomy is closer to a brushland rarely higher than 5m high) and c. 1300 ha of mangroves. Apart from Astove and Cosmoledo atolls, also in the Aldabra group, where *Pemphis acidula* shrubland and limited amounts of dry forest are present, all outer islands have very little native forest left, and vegetation is dominated by abandoned coconut plantations and invasive Casuarina trees with very few native tree species (mainly Takamaka *Callophyllum inophyllum*, Indian Almond Bois blanc *Hernandia nymphaeifolia*, Bonnet carré bord-de-mer *Barringtonia asiatica*, Bois de rose *Thespesia populnea*). Besides, only a very tiny proportion of the Seychelles population lives there, with no permanent local communities but employees of organisations managing or present on these islands (Island Development Company and NGO Island Conservation Society for government outer islands that include a few private hotels, a private owner and NGO Save our Seas for D'Arros/St Joseph atoll, and Seychelles Islands Foundation for Aldabra.

Figure 37 : Relative importance of KBAs in Seychelles for local climate regulation

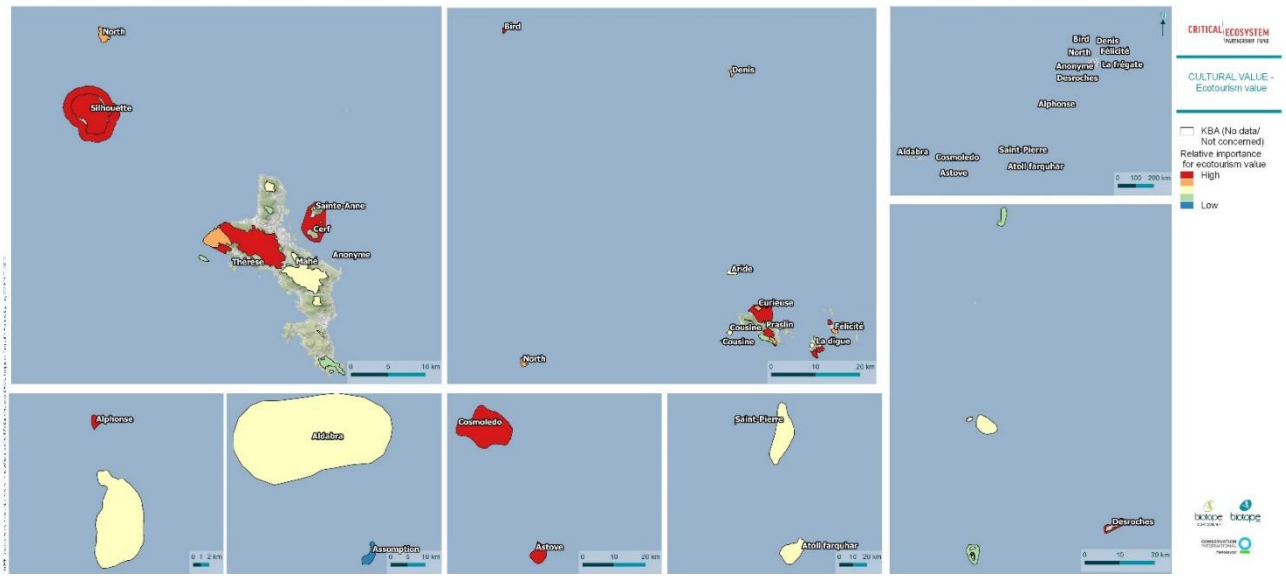


4.3.9 Cultural: Ecotourism

Nature-based tourism is the most important source of revenue for Seychelles, where a large proportion of job opportunities are linked to hotels and the tourism industry. In addition, less intensive and more sustainable forms of tourism aiming at discovering the natural assets of Seychelles (hiking trails, endemic animals and plants, medicinal plants, historical and cultural assets, etc.) with nature guides and in closer contact with local communities is developing in Seychelles aiming at sharing with visitors their cultural and natural assets. Beneficiaries include in particular nature guides and local communities making a living from ecotourism (guest-houses, small-scale farmers, artisanal crafts). The ecotourism value of marine KBAs has been evaluated into detail by TNC (TNC, 2022) using on-reef tourism data, nature-dependent beach tourism, charter sportfishing data, and some data on mangrove Tourism and bird watching.

The annual number of paying visitors in nature reserves (Vallée-de-Mai, Fonds Ferdinand, Cousin, Aride, Curieuse, Aldabra) are known, and an approximate number of visiting clients to small islands with high biodiversity value such as Bird, Denis, Frégate, Ile du Nord, Cousine and Félicité can be approximated from data provided by their owners. Mwebase et al. (2010) gave some approximate values of income generated by some of these sites and how reinvasion by invasive species threatened it. However, because of the limited recording of entries and visitors in the terrestrial KBAs where there are no paying fees (e.g. Morne Seychellois National Park; other official trails in private land), a similar analysis is not possible. It would be possible to account for the number of kilometers of trails, but it would not provide an accurate evaluation. Therefore, we just evaluate a semi-quantitative ranking based on expert knowledge. We regrouped data on the importance of KBAs for this ES by using the semi-quantitative scaling proposed by TNC, using the maximum value for ecotourism as identified by any of the criteria used (e.g. on-reef tourism, bird watching, etc.). This information (Table 16 p. 58 from TNC 2021) can be found in Figure 38 below.

Figure 38 : Relative importance of KBAs in Seychelles for ecotourism

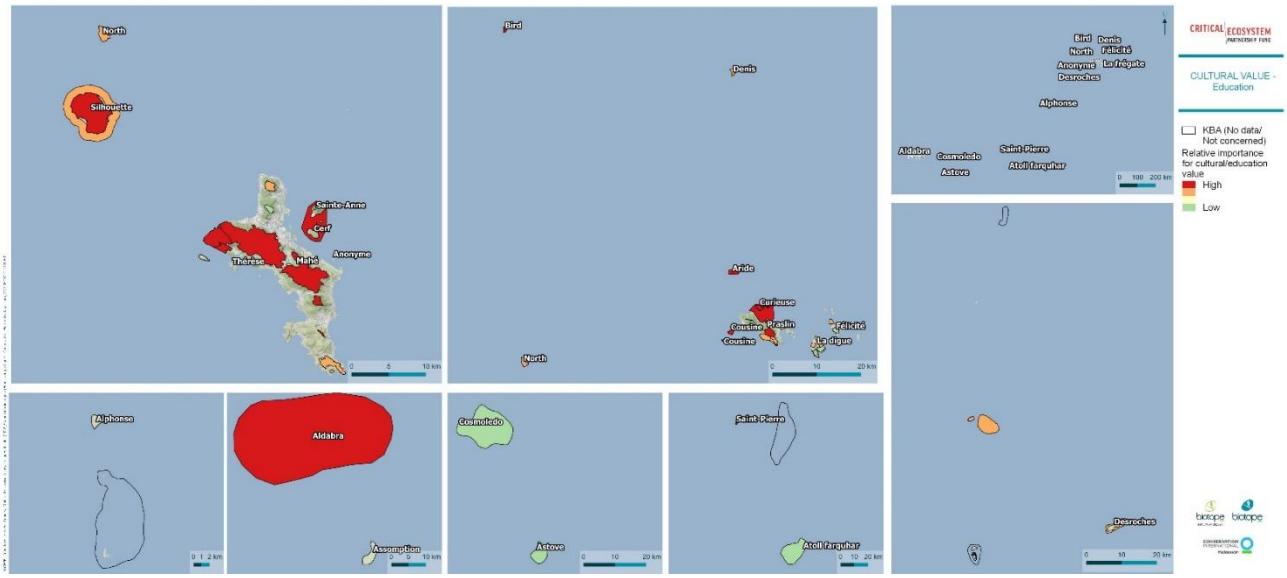


4.3.10 Cultural: Cultural and educational value

The natural environment is closely linked to cultural values of local communities. It therefore provides an important ecosystem service by linking people to their culture and history. Some sites, such as Aldabra World Heritage Site, but also other remote atolls such as Cosmoledo or Farquhar, or natural sanctuaries such as Aride or Cousin islands, have a lot of importance in Seychellois culture and spirituality.

Moreover, functioning ecosystems provide environmental education opportunities for children and scholars. By lack of quantitative data, we evaluate the relative importance of KBAs for educational and cultural aspects using a semi-quantitative evaluation based on expert knowledge. Higher values of the index are used for KBAs that are used – or that have the potential to be used - for education purpose such as excursions for school visits or field work for university students.

Figure 39 : Relative importance of KBAs in Seychelles for cultural and educational value



4.3.11 Multicriteria analysis: Ranking of KBAs

Based on the bibliography review and the consultations, each priority ecosystem service was assessed for each KBAs resulting in the table below.

The relative importance of each KBA for each ES is rated as: 0 = Absent; 1 = Low; 2 = Medium; 3 = High; 4 = Very High. The multicriteria index is based on the sum of the relative importance multiplied by the weighting for the 10 ecosystem services. The KBAs are presented in decreasing order of the multicriteria index value

Table 26 : Compilation of the main results for the evaluation of the relative importance of the 10 Ecosystem Services for each of the 57 KBAs listed by CI (2014).

Code	Island Group	Terrestrial / Marine	KBA Name	Provisioning				Regulation and maintenance				Cultural		Multi-criteria index (weighted)
				Commercial fisheries	Water for domestic use	Forest products	Medicine	Local climate regulation	Cyclone protection	Flood protection	Sustaining habitats and genetic diversity	Eco-tourism	Cultural and educational value	
			Weight coefficient	***0.125***	***0.125***	***0.09375***	***0.03125***	***0.09375***	***0.125***	***0.125***	***0.125***	***0.09375***	***0.0625***	***1***
SYC-43	Inner	T	Morne Seychellois National Park	0	4	4	4	4	0	3	4	4	4	0.719
SYC-38	Inner	T	Montagne Planneau (Grand Bois-Varigault-Cascade)	0	4	2	3	4	0	4	4	2	3	0.633
SYC-41	Inner	T	Praslin National Park	0	3	4	2	3	0	2	3	4	4	0.586
SYC-42	Inner	T	Silhouette National Park	0	3	1	1	4	0	2	4	4	4	0.563
SYC-36	Inner	T	Montagne Brûlée-Piton de l'Eboulis	0	1	3	3	2	0	4	3	2	4	0.500
SYC-50	Aldabra	M/T	Aldabra Special Reserve	4	1	0	0	1	1	0	4	3	4	0.469
SYC-47	Inner	M	Port Launay Marine National Park and coastal wetlands	3	0	0	0	0	3	1	3	4	4	0.469
SYC-15	North edge	T	Bird Island (Ile aux Vaches)	4	1	1	0	1	1	0	3	4	3	0.469
SYC-5	Cosmoledo	M/T	Cosmoledo	4	1	0	0	0	1	0	4	4	3	0.453
SYC-51	Inner	M/T	Aride Island Special Reserve	4	1	0	0	1	1	0	3	4	3	0.445
SYC-52	Inner	M/T	Cousin Island Special Reserve	4	1	0	0	1	1	0	3	4	3	0.445
SYC-48	Inner	M	Sainte-Anne Marine National Park (SAMNP)	3	0	0	0	0	3	0	3	4	4	0.438
SYC-20	North edge	T	Denis Island	4	1	1	0	1	1	0	3	3	2	0.430
SYC-46	Inner	M	Curieuse Island Marine National Park	3	0	0	0	0	3	0	3	4	2	0.406
SYC-32	Amirantes	M/T	Saint-François and Bijoutier Islands	4	0	0	0	0	2	0	4	4	0	0.406
SYC-3	Cosmoledo	M/T	Astove	4	1	0	0	1	1	0	3	4	0	0.398

Code	Island Group	Terrestrial / Marine	KBA Name	Provisioning				Regulation and maintenance				Cultural		Multi-criteria index (weighted)
				Commercial fisheries	Water for domestic use	Forest products	Medicine	Local climate regulation	Cyclone protection	Flood protection	Sustaining habitats and genetic diversity	Eco-tourism	Cultural and educational value	
SYC-18	Inner	T	Curieuse Island	0	1	3	0	1	0	1	3	4	3	0.391
SYC-19	Amirantes	M/T	D'Arros Island and Saint Joseph Atoll	4	1	1	0	0	1	0	3	2	2	0.383
SYC-6	Farquhar	M/T	Farquhar - South Island and islets	4	0	0	0	0	1	0	4	2	3	0.375
SYC-9	Inner	T	Fond Ferdinand	0	2	3	0	1	0	0	3	3	2	0.352
SYC-49	Inner	M	Silhouette Marine National Park	3	0	0	0	0	1	0	3	4	2	0.344
SYC-22	Amirantes	M	Desroches Island - surrounding reefs	2	1	0	0	0	2	0	2	4	2	0.344
SYC-25	Amirantes	M/T	Alphonse Island and Lagoon	2	1	0	0	0	2	0	2	4	2	0.344
SYC-39	Inner	T	Nid d'Aigle (ridge and eastern slopes)	0	2	1	0	2	0	2	2	2	2	0.336
SYC-23	Inner	T	North Island (Ile du Nord)	1	1	1	0	1	1	0	3	3	2	0.336
SYC-56	Inner	T	Val d'Endor	0	2	0	3	1	0	3	1	2	3	0.328
SYC-26	Inner	T	Félicité Island	1	1	1	0	1	1	0	3	3	1	0.320
SYC-17	Inner	T	Cousine Island	2	1	0	0	1	1	0	3	2	2	0.320
SYC-27	Inner	T	Frégate Island	1	1	1	1	1	0	0	3	3	2	0.313
SYC-2	Inner	T	Anse Source d'Argent-Anse Marron	1	1	1	0	1	1	0	2	4	1	0.313
SYC-44	Inner	M	Cap Ternay / Baie Ternay Marine National Park	3	0	0	0	0	1	0	2	3	3	0.305
SYC-7	Inner	T	Fond Azore southern slopes to Anse Bois de Rose	0	1	1	0	3	0	1	3	1	2	0.305
SYC-34	Amirantes	M	Poivre Lagoon and surrounding reefs	4	1	0	0	0	1	0	2	2	0	0.297
SYC-45	Inner	M	Ile Cocos Marine National Park	4	0	0	0	0	1	0	1	3	2	0.289
SYC-21	Amirantes	T	Desnoeufs Island	3	1	0	0	0	1	0	2	1	3	0.289
SYC-12	Inner	T	Grand Anse-Petite Anse-Fond Piment	0	1	1	0	3	0	0	2	4	0	0.281
SYC-53	Inner	T	La Veuve Special Reserve	0	0	1	0	1	0	2	2	3	2	0.273
SYC-28	Amirantes	T	Marie-Louise Island	3	1	0	0	0	1	0	2	1	1	0.258
SYC-10	Inner	T	L'Amitié Forest	0	1	1	0	2	0	2	2	1	0	0.250
SYC-37	Inner	T	Montagne Glacis - When she comes	0	1	1	0	2	0	0	2	2	2	0.242

Code	Island Group	Terrestrial / Marine	KBA Name	Provisioning				Regulation and maintenance				Cultural		Multi-criteria index (weighted)
				Commercial fisheries	Water for domestic use	Forest products	Medicine	Local climate regulation	Cyclone protection	Flood protection	Sustaining habitats and genetic diversity	Eco-tourism	Cultural and educational value	
SYC-4	Amirantes	M	African Banks	4	0	0	0	0	1	0	2	1	0	0.242
SYC-24	Farquhar	M/T	Providence Island and Bank	1	0	0	0	0	1	0	4	2	0	0.234
SYC-29	Inner	T	Sainte-Anne Island	0	1	1	1	1	0	0	1	3	3	0.234
SYC-11	Inner	T	Montagne Corail-Collines du Sud dry forests	0	1	0	0	2	0	0	3	1	2	0.227
SYC-13	Inner	T	Grand Police wetlands	1	0	0	0	2	0	1	1	2	2	0.219
SYC-1	Inner	M	Anse Major / Anse Jasmin (marine area of MSNP)	1	0	0	0	3	0	0	1	3	1	0.219
SYC-14	Aldabra	M/T	Assomption Island	1	0	0	0	1	1	0	3	1	1	0.219
SYC-31	Amirantes	T	Etoile and Boudeuse Islands	4	0	0	0	0	0	0	2	1	0	0.211
SYC-57	Inner	T	La Misère-Dauban area: La Misère	0	1	1	0	1	0	1	1	1	2	0.195
SYC-8	Inner	T	Fond Diable and Pointe Joséphine	0	0	1	0	2	0	1	2	1	0	0.188
SYC-40	Inner	T	Recif Island National Park	1	0	0	0	0	0	0	2	1	2	0.148
SYC-35	Inner	T	Mont Signal	0	0	1	0	1	0	1	1	1	1	0.148
SYC-33	Inner	T	Ilot Frégate	0	0	0	0	1	0	0	2	1	1	0.125
SYC-16	Inner	T	Conception Island	1	0	0	0	1	0	0	1	1	1	0.125
SYC-54	Inner	T	Kerlan River	0	1	0	0	1	0	0	1	1	0	0.109
SYC-55	Inner	T	Anse Petite Cour Boulders	0	0	0	0	1	0	0	1	1	0	0.078
SYC-30	Farquhar	T	Saint-Pierre Island	0	0	0	0	0	0	0	1	1	0	0.055

Based on the results of the multicriteria analysis, the priority sites for Seychelles are the 20 first KBA from the analysis:

Table 27 : List of priority KBA for Seychelles

KBA No.	Island Group	T/M	KBA name	Weighted index	Rank
SYC-43	Inner	T	Morne Seychellois National Park	0.719	1
SYC-38	Inner	T	Montagne Planneau (Grand Bois-Varigault-Cascade)	0.633	2
SYC-41	Inner	T	Praslin National Park	0.586	3
SYC-42	Inner	T	Silhouette National Park	0.563	4
SYC-36	Inner	T	Montagne Brûlée-Piton de l'Eboulis	0.500	5
SYC-50	Aldabra	M/T	Aldabra Special Reserve	0.469	6
SYC-47	Inner	M	Port Launay Marine National Park and coastal wetlands	0.469	6
SYC-15	North edge	T	Bird Island (Ile aux Vaches)	0.469	6
SYC-5	Cosmoledo	M/T	Cosmoledo	0.453	9
SYC-51	Inner	M/T	Aride Island Special Reserve	0.445	10
SYC-52	Inner	M/T	Cousin Island Special Reserve	0.445	10
SYC-48	Inner	M	Sainte-Anne Marine National Park (SAMNP)	0.438	12
SYC-20	North edge	T	Denis Island	0.430	13
SYC-46	Inner	M	Curieuse Island Marine National Park	0.406	14
SYC-32	Amirantes	M/T	Saint-François and Bijoutier Islands	0.406	14
SYC-3	Cosmoledo	M/T	Astove	0.398	16
SYC-18	Inner	T	Curieuse Island	0.391	17
SYC-19	Amirantes	M/T	D'Arros Island and Saint Joseph Atoll	0.383	18
SYC-6	Farquhar	M/T	Farquhar - South Island and islets	0.375	19
SYC-9	Inner	T	Fond Ferdinand	0.352	20

Figure 40 : Relative importance of KBAs for providing multuplie ecosystem services

Following the stakeholder consultation, 20 priority sites were selected for Seychelles. This number, which is higher than the expected number of grants for Seychelles by CEPF for the next investment phase, was chosen because :

- Seychelles is made up of various small islands with a high, heterogeneous and pertinent value,
- Financing for KBA conservation is disparate,
- Most of the KBAs are managed by government authorities,
- This offers more possibilities for small sites.

The high number of sites does not mean that all the sites will benefit from grants from CEPF but they got a chance to apply for them.

Conclusion

As part of the WP1, this report presents the priority ecosystem services identified in the Indian Ocean Islands and identify the KBAs where they are relevant.

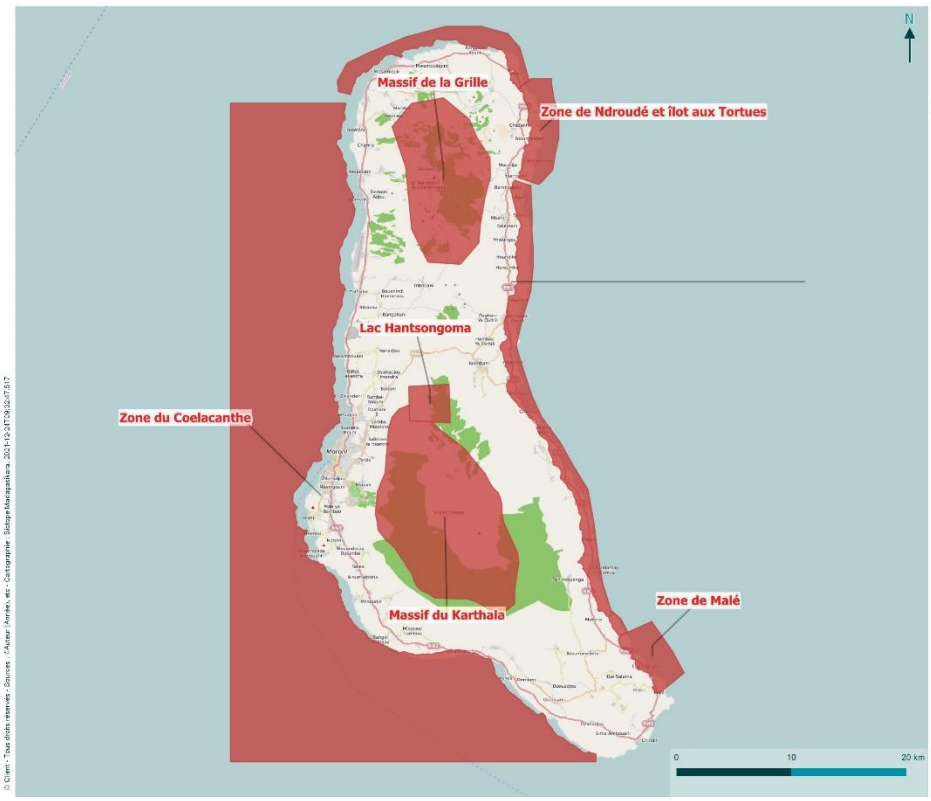
The prioritization of ecosystem services was based mainly on literature review and expert knowledge of the KBAs, validated through stakeholder consultations at the subnational and national levels. Stakeholders also validated our approach and the selection and ranking of priority KBAs according to the importance of each priority ecosystem services.

A total of nine, seven and 10 priority ecosystem services were identified in the Comoros, Mauritius and Seychelles, respectively. These ecosystem services were then used to rank KBAs in each country based on their relative importance for the delivery of ecosystem services important for climate change resilience. The highest ranked KBAs in this exercise were then proposed as priorities for CEPF investment in Ecosystem-based Adaptation: 10 in the Comoros; 10 in Mauritius; and 20 in Seychelles.

Appendix 1: Comoros - Detailed maps of KBAs

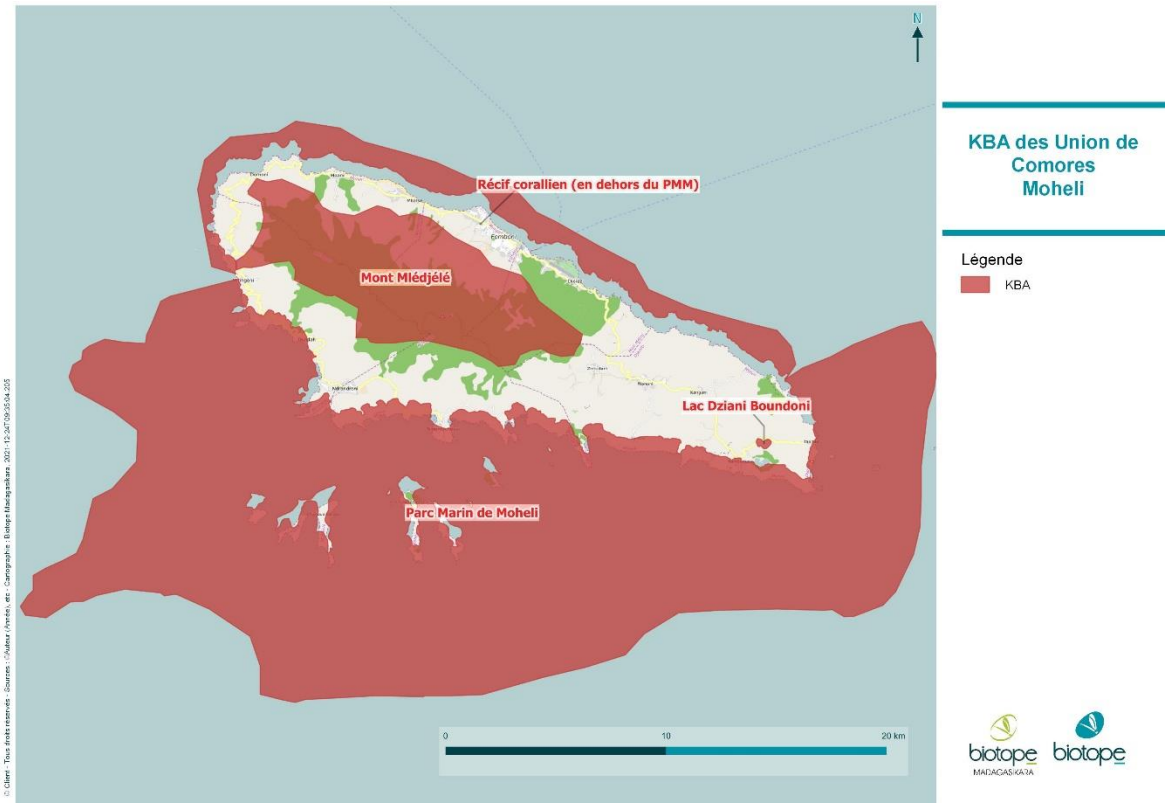
KBA des Union de Comores Anjouan

Légende
KBA

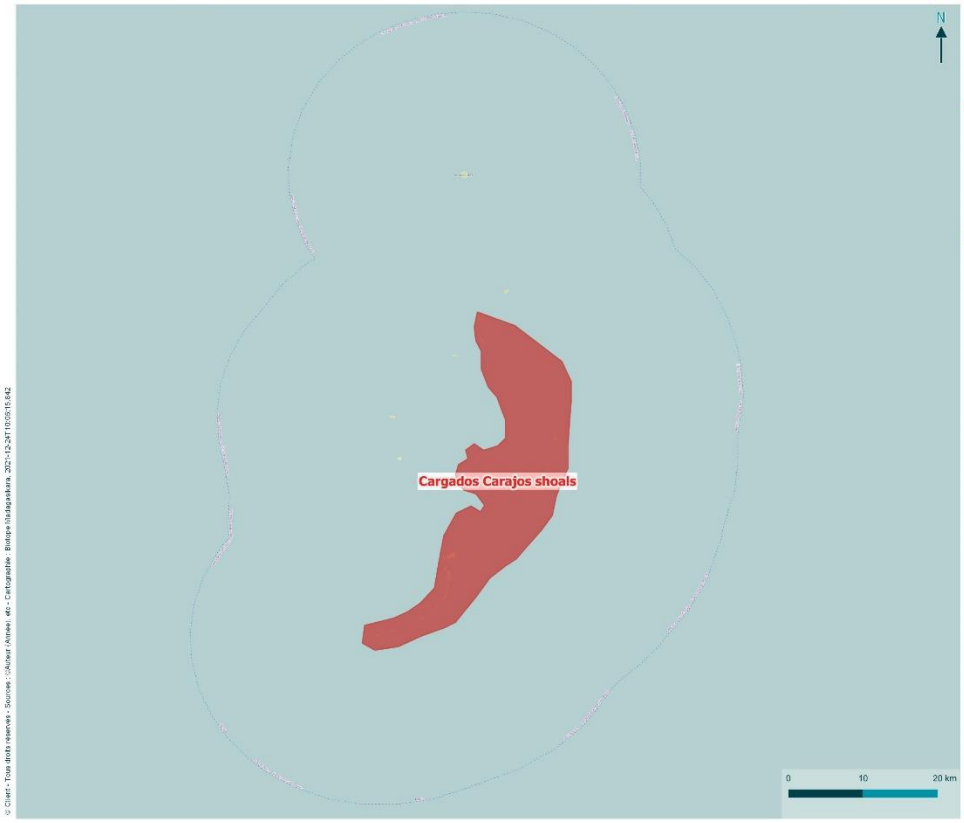


KBA des Union de Comores Grande comore

Légende
KBA


N
Récif corallien (en dehors du PMM)
Mont Mlédjélé
Lac Dziani Boundoni
Parc Marin de Moheli
0
10
20 km
KBA des Union de Comores Moheli
Légende
KBA

Appendix 2: Mauritius – Detailed maps of KBAs

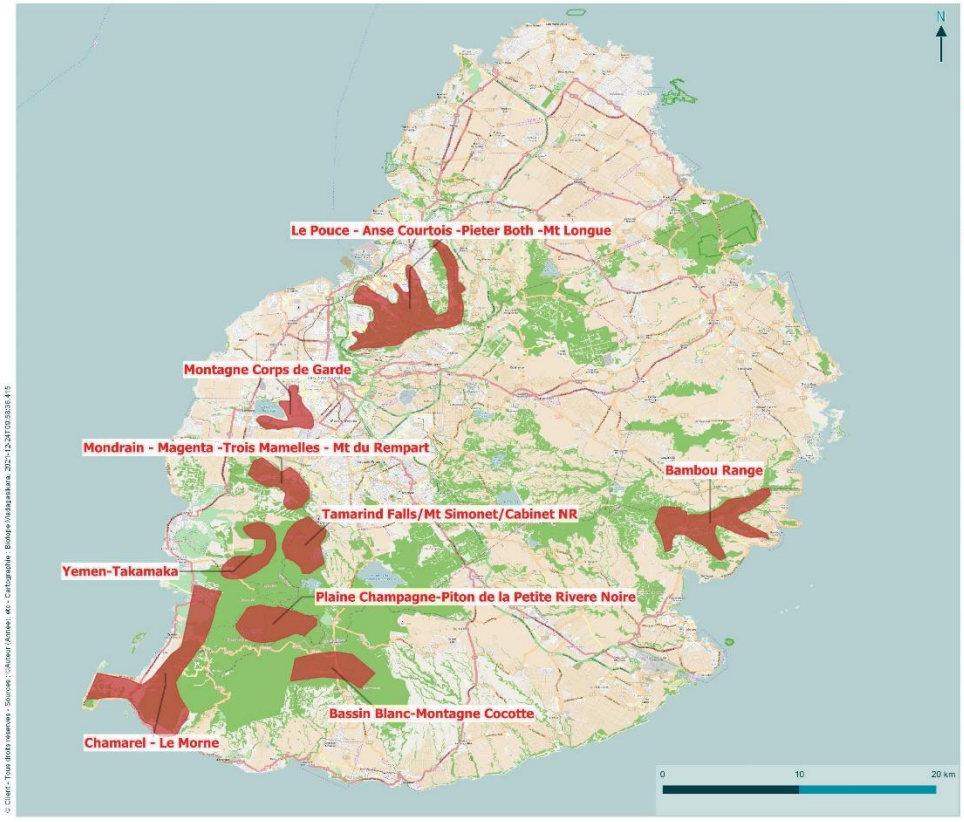


KBA de la république de Maurice

île Cargados Carajos

Légende

KBA

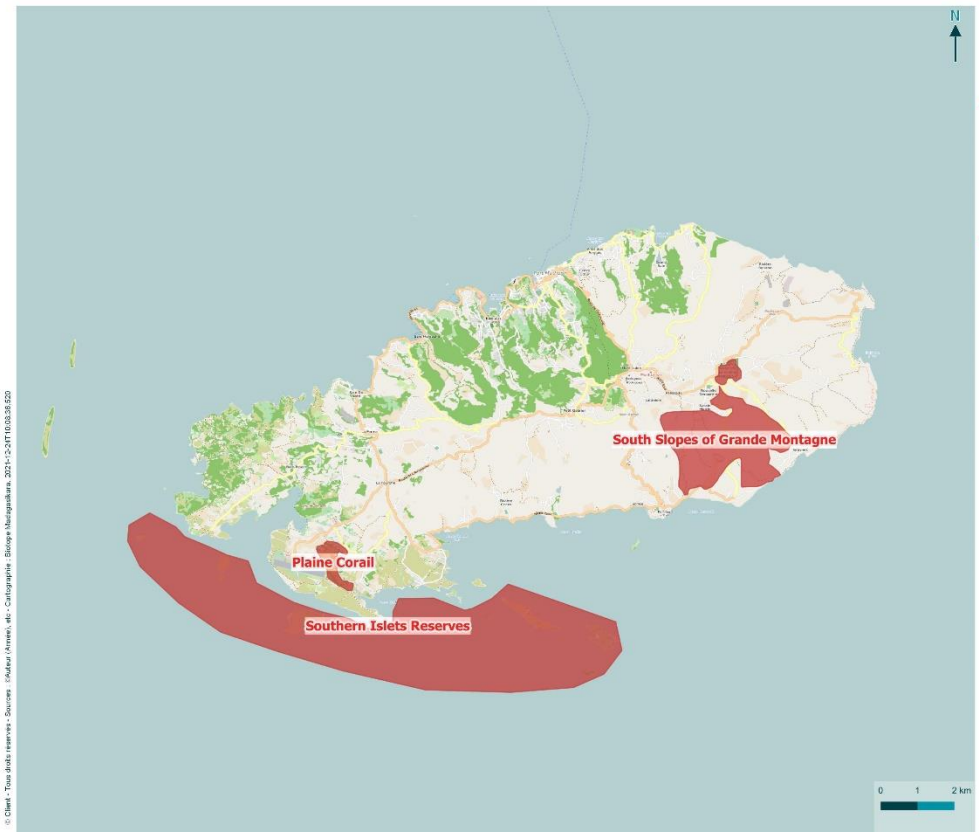


KBA de la république de Maurice

île Maurice

Légende

KBA



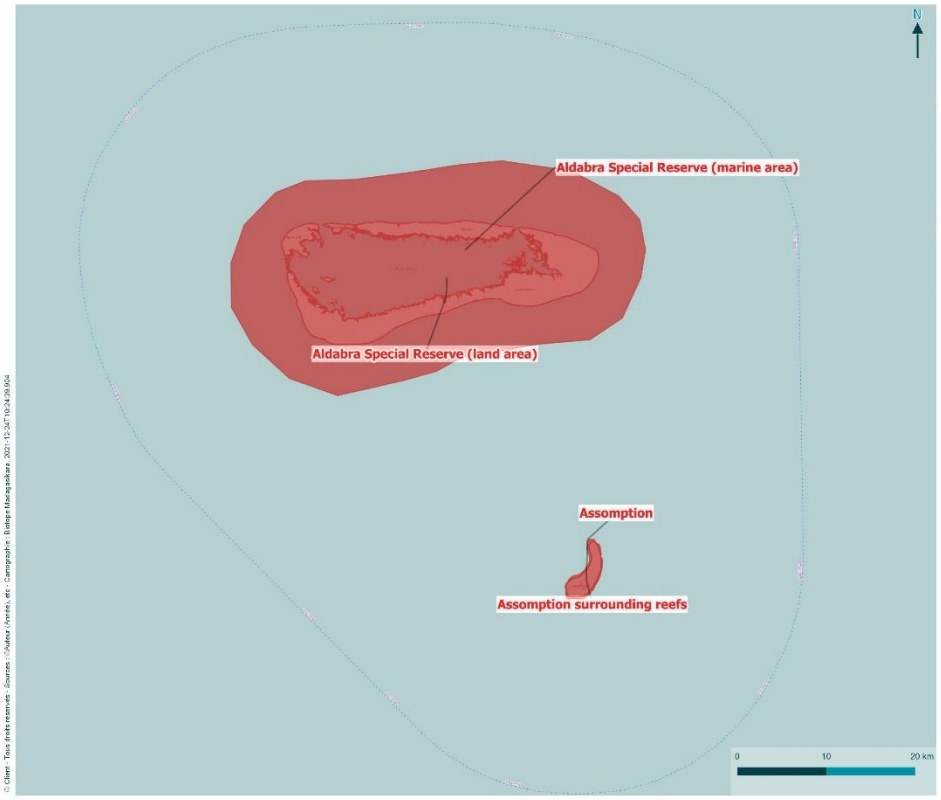
KBA de la république de Maurice

île Rodrigue

Légende

KBA

Appendix 3: Seychelles – Detailed maps of KBAs



KBA de la république des Seychelles
Aldabra

Légende
KBA

KBA de la république des Seychelles

Anse, île Aride et île Félicité

Légende
KBA

KBA de la république des Seychelles

Atoll de Cosmoledo

Légende

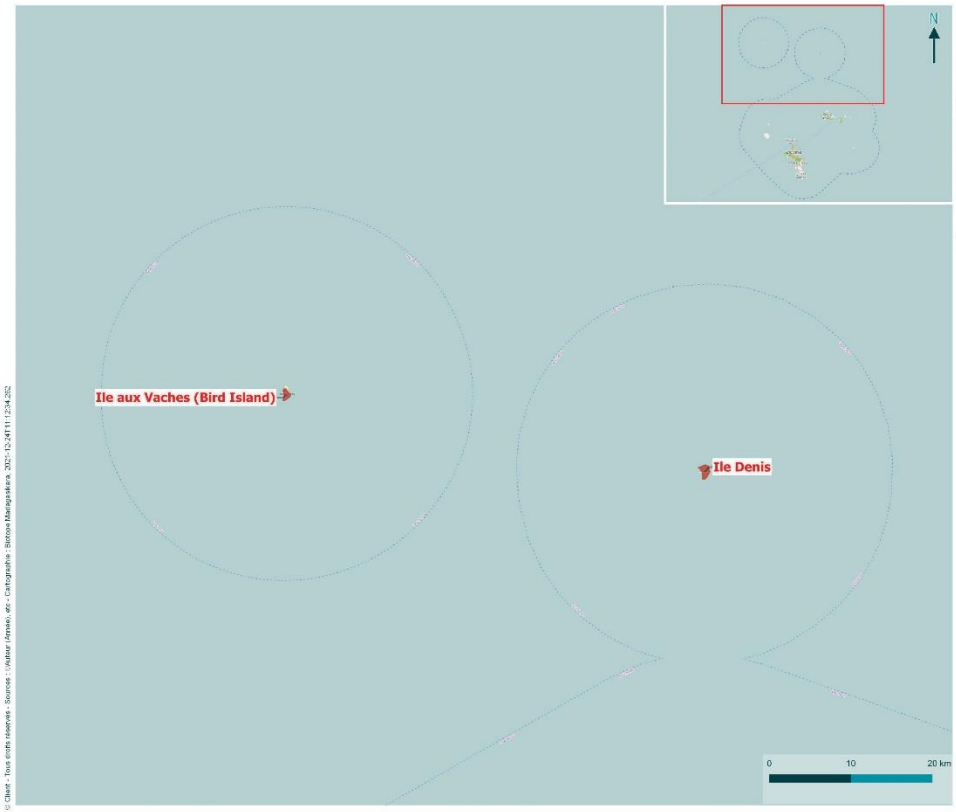
KBA

KBA de la république des Seychelles

Atoll de Farquhar

Légende

KBA

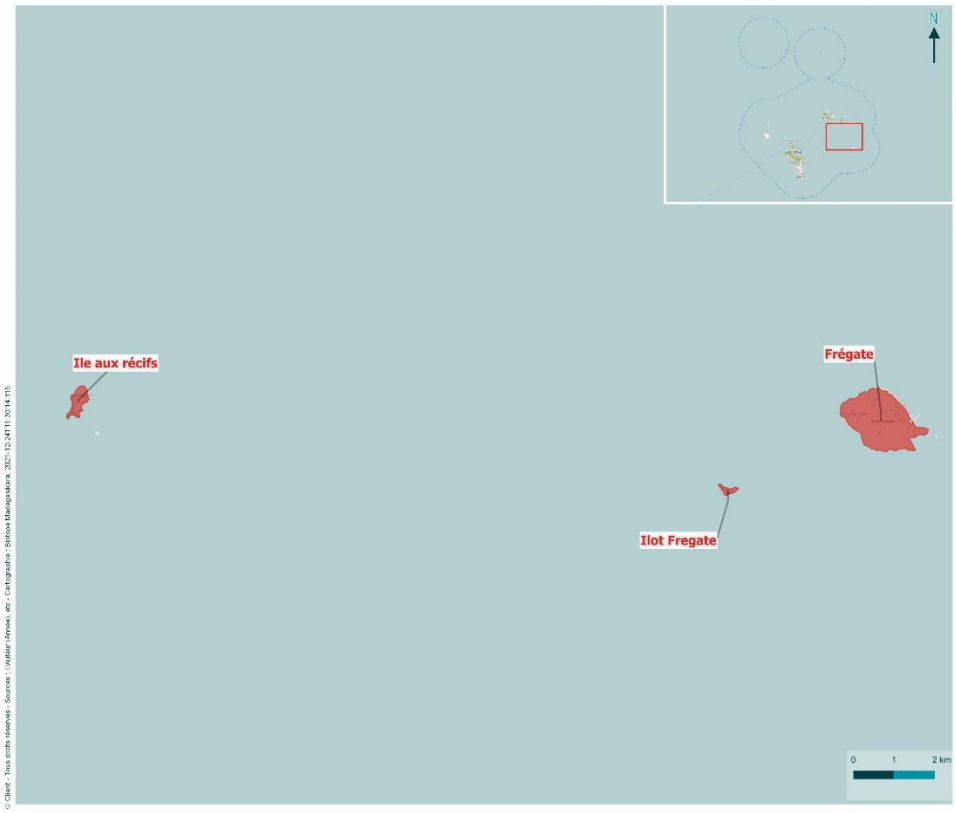


KBA de la république des Seychelles

Bird Island et îles denis

Légende

KBA

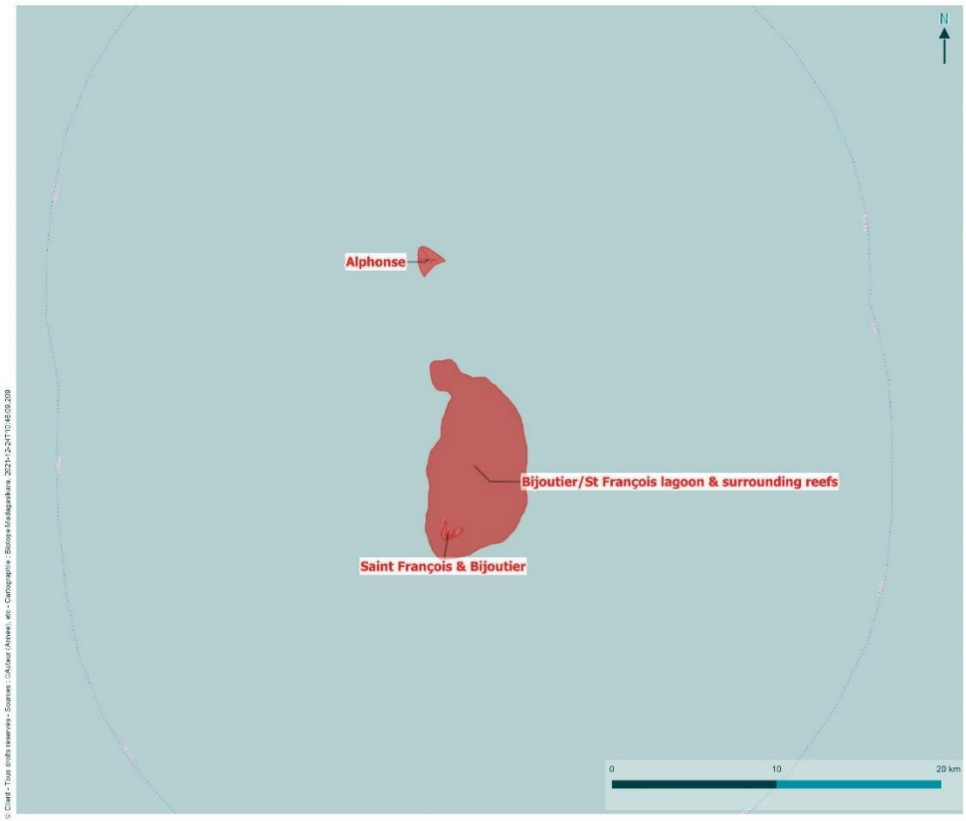


KBA de la république des Seychelles

île Fregate et île aux Récifs

Légende

KBA

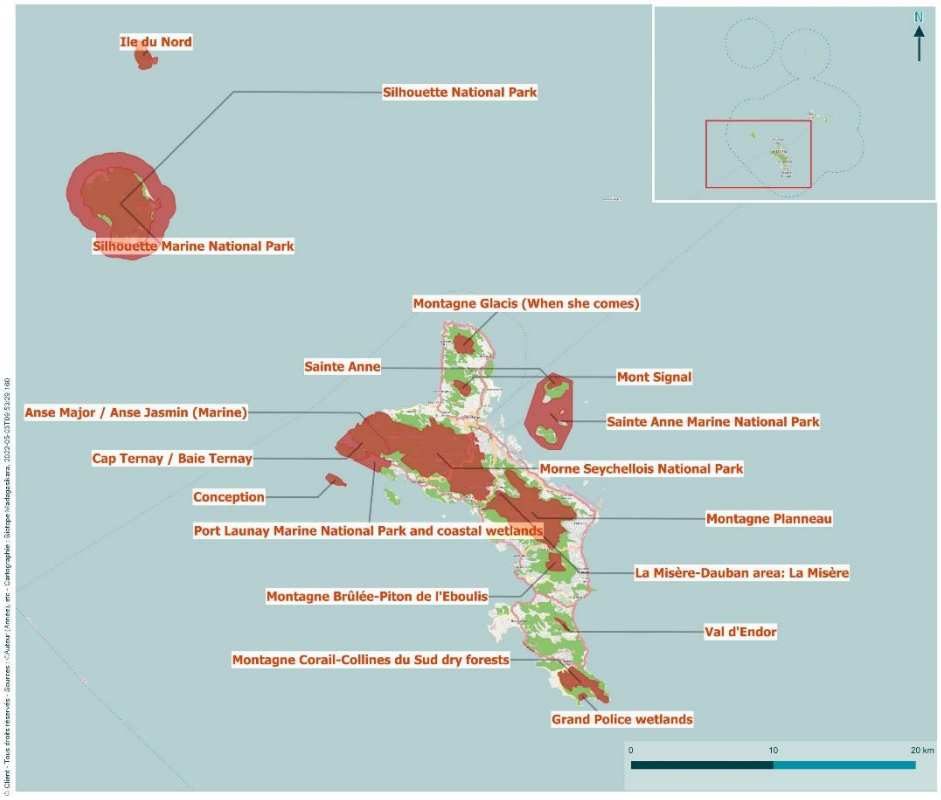


KBA de la république des Seychelles

îles St François et Alphonse

Légende

KBA



KBA de la république des Seychelles

îles Victoria

Légende

KBA

KBA de la république des Seychelles

Poivre

Légende

KBA

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