REPUBLIC OF MAURITIUS

Ministry of Agro-Industry and Food Security

National Biodiversity Strategy and Action Plan

2017 – 2025

May 2017

PART I

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Participants in the NBSAP Validation Workshop, 14-15 February 2017 (Photo: Shakil Beedassy)

Message by the Honourable Mahen Kumar Seeruttun, Minister of Agro-Industry and Food Security

I have the honour to present the National Biodiversity Strategy and Action Plan 2017-2025 for the Republic of Mauritius, which sets out the Strategy and Action Plan for biodiversity conservation for the next nine years.

The Republic of Mauritius was the first country to sign and ratify the Convention on Biological Diversity in September 1992 and by so doing, gave a strong signal and a clear statement that necessary measures would be taken to protect our unique biodiversity.

Mauritius, as a Small Island Developing State (SIDS) faces a lot of challenges such as climate change, isolation, impact of Invasive Alien Species and lack of adequate resources. The National Biodiversity Strategy and Action Plan (NBSAP) 2017 – 2025 which follows the NBSAP developed in 2006, sets out clear goals and objectives which the country targets to achieve in terms of biodiversity conservation.

The 20 Aichi Targets presented in the document have been thoroughly worked out with the assistance of numerous stakeholders. The document is an important tool for guaranteeing biodiversity conservation in the Republic of Mauritius. It also presents a global overview on the status of biodiversity conservation.

I wish to express my appreciation to all stakeholders who participated in the different workshops for the NBSAP project and to thank them for their valuable suggestions and recommendations for the elaboration of this Strategy and Action Plan. I also commend the NBSAP team for their dedication and hard work and the Global Environment Fund (GEF) and the United Nations Development Programme (UNDP) for their support in producing this document.

I am confident that this document will allow us to consolidate the gains, enhance synergy and channel a more concerted effort towards biodiversity protection and conservation.

Mahen Kumar Seeruttun

Minister of Agro-Industry and Food Security

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Acronyms and Abbreviations

ABS	Access and Benefit Sharing	MESDDBM	Ministry of Environment, Sustainable Development, Disaster and Beach Management (former name of MSSNSESD)
ACTS	African Centre for Technology Studies	METT	Management Effective Tracking Tool
AEWA	African Eurasian Waterbird Agreement	MFED	Ministry of Finance and Economic Development
AFRC	Albion Fisheries Research Centre	MMCS	Mauritius Marine Conservation Society
AGO	Attorney General's Office	MOEMRFS	Ministry of Ocean Economy, Marine Resources, Fisheries, and Shipping
ATR	Associations du Tourisme Réunies	MOI	Mauritius Oceanography Institute
BBMP	Blue Bay Marine Park	MPA	Marine Protected Area
BOI	Board of Investment	MSIRI	Mauritius Sugar Industry Research Institute
BRGNP	Black River Gorge National Park	MSP	Marine Spatial Plan
CBD	Convention on Biological Diversity	MSSNSESD	Ministry of Social Security, National Solidarity and Environment and Sustainable Development
CEB	Central Electricity Board	MUR	Mauritian Rupees
CEPF	Critical Ecosystems Partnership Fund	MWF	Mauritian Wildlife Foundation
CHM	Clearing-House Mechanism	NBSAP	National Biodiversity Strategy and Action Plan
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora	NCS	National Conservation Strategy
CLC	Civil Liability Convention	NDS	National Development Strategy
CMS	Bonn Convention on Migratory Species	NEAP	National Environmental Action Plan
CoA	Commission of Agriculture	NEP	The National Environmental Policy
COMESA	Common Market for Eastern and Southern Africa	NFP	National Focal Point
CSR	Corporate Social Responsibility	NGO	Non-Governmental Organisation
CWA	Central Water Authority	NIASC	National Invasive Alien Species Committee
CWR	Crop Wild Relatives	NIASSAP	National Invasive Alien Species Strategy and Action Plan
DCSMZAE	Department for Continental Shelf, Maritime Zones Administration and Exploration	NPCS	National Parks and Conservation Services
EEZ	Exclusive Economic Zone	NTBNPA	Native Terrestrial Biodiversity and National Parks Act
EIA	Environmental Impact Assessment	OIDC	Outer Islands Development Corporation
EIP	Environmental Investment Programme	OPRC-HNS Protocol	Protocol on preparedness, response and cooperation to pollution incidents by hazardous and Noxious Substances

EPMU	Economic Planning and Monitoring Unit	PA	Protected Area
ESA	Environmentally Sensitive Area	PAN	Protected Area Network
FAREI	Food and Agricultural Research and Extension Institute	PANES	Protected Area Network Expansion Strategy
FPS	Fisheries Protection Service	PER	Preliminary Environmental Report
FRTU	Fisheries Research and Training Unit	PGR	Plant Genetic Resources Unit
FS	Forestry Services	PMO	Prime Minister's Office
GEF	Global Environment Facility	PPG	Planning Policy Guidance
GIS	Geographic Information System	RAP	Rodrigues Action Plan
GMO	Genetically modified organism	RCM	Reef Conservation Mauritius
GN	Government Notice	REC	Rodrigues Environment Committee
GoM	Government of Mauritius	REU	Rodrigues Environment Unit
GREEN	Global Rivers Environmental Education Network	RoM	Republic of Mauritius
IAA	Ile aux Aigrettes	RRA	Rodrigues Regional Assembly
IAS	Invasive Alien Species	SADC	Southern African Development Community
IBA	Important Bird and Biodiversity Area	SCBD	Secretariat of the Convention on Biological Diversity
ICZM	Integrated Coastal Zone Management	SCP	Sustainable Consumption and Production
IOC	Indian Ocean Commission	SDG	Sustainable Development Goals
IOTC	Indian Ocean Tuna Commission	SEMPA	South East Marine Protected Area
IUCN	International Union for Conservation of Nature	SIDS	Small Island Developing States
KBA	Key Biodiversity Area	SPU	Strategic Policy Unit (SPU) under the PMO
KPI	Key performance indicator	UNCCD	Convention to Combat Desertification in Africa
MAC	Ministry of Arts and Culture	UNCLOS	UN Convention on the Law of the Sea
MAIF	Ministry of Agro-Industry and Fisheries (former name of MAIFS)	UNDP	United Nations Development Programme
MAIFS	Ministry of Agro-Industry and Food Security	UNFCCC	UN Framework Convention on Climate Change
MAP	Mauritius Action Plan	UoM	University of Mauritius
MARPOL	Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal	WMA	Wastewater Management Authority
MDR	Ministry of Defence and Rodrigues	WRU	Water Resources Unit
MEA	Multilateral Environmental Agreement	WWF	World Wildlife Fund

Executive summary

The Mauritius National Biodiversity Strategy and Action Plan (NBSAP) 2017 – 2025 has been prepared through an iterative process of stakeholder consultations and approval, addressing Mauritius' obligations under Article 6a of the Convention on Biological Diversity (CBD). This NBSAP replaces its previous version (2006 – 2015) and builds upon a review of its predecessor and several preparatory documents, namely a biodiversity mainstreaming assessment for key industries and themes, an ecosystem valuation study for the catchment areas of Mare Longue and Mare-aux-Vacoas and an ecosystem-based adaptation study for a more resilient protected area network.

The introduction of the NBSAP 2017 - 2025 presents a concise account of the necessary background, sets the scene for the updated NBSAP and provides the rationale for the strategy and actions contained in the NBSAP. Section 1.1 focusses on the values of biodiversity and ecosystem services in the country and their contribution to human well-being, highlighting the status and trends in biodiversity in Mauritius and Rodrigues. Section 1.2 summarises the main threats and their underlying causes of biodiversity loss, including its main consequences. Section 1.3 presents the national constitutional, legal and institutional frameworks and policies which underpin all activities related to the conservation and sustainable use of biodiversity. Section 1.4 highlights the challenges in biodiversity mainstreaming to date, in reference to the findings of the preparatory study "*Advances in cross-sectoral mainstreaming of biodiversity in Mauritius*", and summarises the process of developing the updated NBSAP for 2017 – 2025.

The second part of this document presents the vision, mission statement, working principles, strategic objectives and targets for the NBSAP of the RoM. The RoM has called for all stakeholders to set up ambitious but realistic national targets, considering local challenges, especially in terms of financial resources, human capacity and time constraints. The RoM has retained the five CBD strategic goals and has adapted the corresponding Aichi Targets to the national context, values and interests. Given the highly-threatened biodiversity and seriously degraded natural capital stocks of the RoM, it is critical that all Mauritian stakeholders change their perspective from one focused on preserving the little that is left to one based on restoring (even creating) natural capital through new forms of development and innovation.

The third part of this document presents the two action plans for the RoM. Because Rodrigues gained autonomous status in 2001 and is governed by the Rodrigues Regional Assembly, a separate action plan was developed for the island and its associated islets. These action plans specify the key programmes and activities, Lead Agency and Partners, priorities, timeframes, and provisional budgets.

The fourth part of the NBSAP for the RoM summarises the plans for capacity development in key identified gap areas and the approach chosen for communication and outreach on the NBSAP.

It also summarises its components and the activities planned for developing a Resource Mobilisation Strategy for both Mauritius and Rodrigues.

To ensure the success of this NBSAP, fundamental issues of resourcing, both financial and human capacity, are to be addressed as a priority, hence the priority given to the development of the Resource Mobilisation Strategy in 2017 (national target 20). It shall confirm the financial resources needed to implement the two action plans of the NBSAP and shall specify the activities (e.g. technical cooperation) and policy changes (e.g. green tax reform) required to mobilise them through all sources, including the domestic budget, external assistance (where relevant) and innovative financial mechanisms, whose implementation will require full support and sustained commitment from the Government of Mauritius, its ministries and partners

Finally, the fifth section of this report explains the coordination at the national level, and sub-nationally (Mauritius and Rodrigues), presents the newly developed Clearing House Mechanism website and the process for the NBSAP monitoring and evaluation. This NBSAP has a 9-year duration (2017 – 2025), with a mid-term review planned for 2020.

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1. INTRODUCTION TO THE REPUBLIC OF MAURITIUS

The Republic of Mauritius (RoM) is located in the Indian Ocean (Figure 1.1), 800 km southeast of Madagascar. It includes the Islands of Mauritius, Rodrigues, Agalega, Tromelin, Cargados Carajos (St Brandon) and the Chagos Archipelago, including Diego Garcia (Figure 1.1). Mauritius gained its independence on 12th March 1968 and became a Republic on 12th March 1992. Mauritius is a stable, multiparty parliamentary democracy.

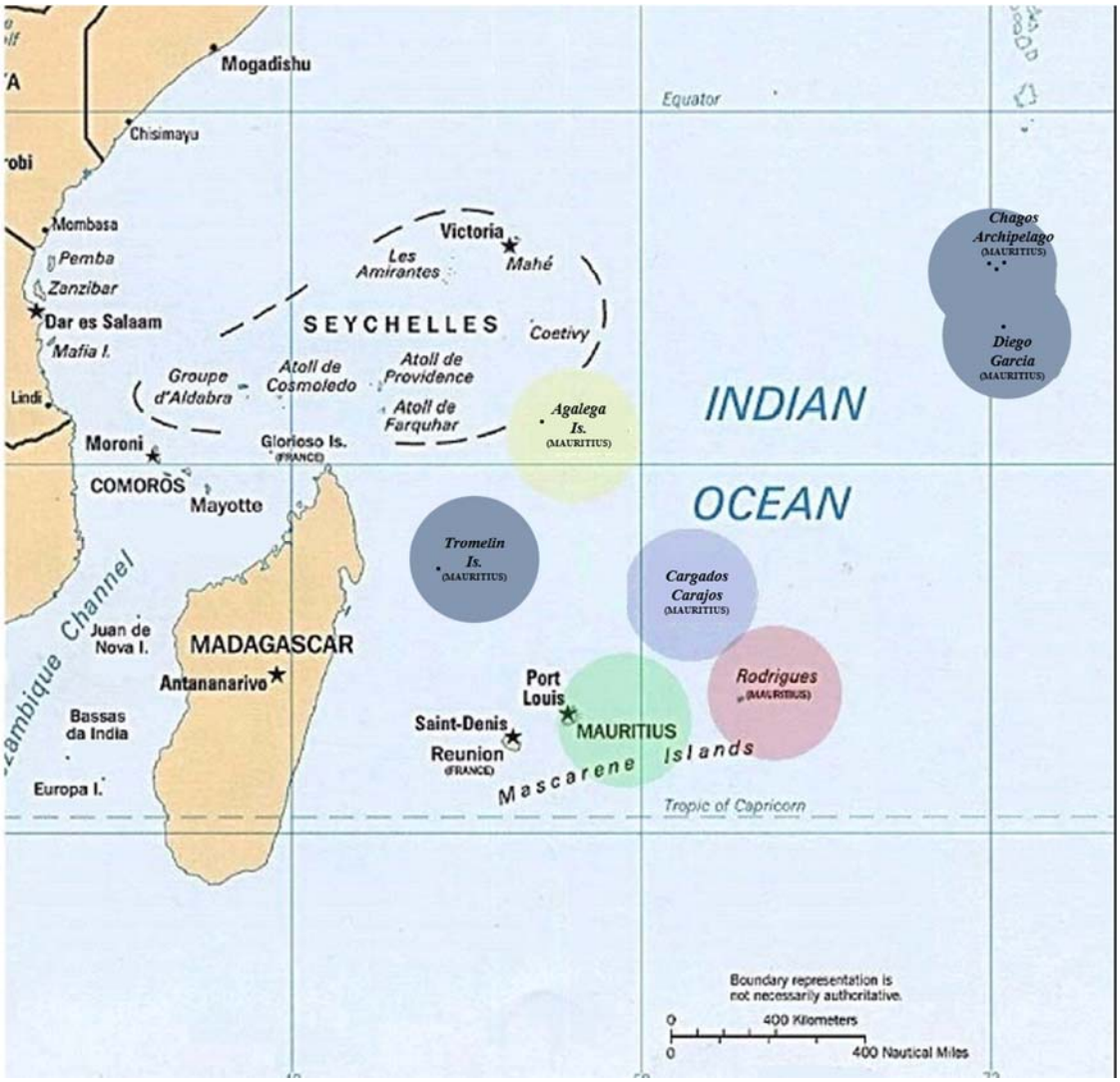

Figure 1.1: Location of Mauritius (source: NBSAP 2006 - 2015)

Mauritius possesses immense maritime zones of approximately 2.3 million km^2. The coastline of the Island of Mauritius stretches over 322 km and it is almost entirely surrounded by a fringing coral reef enclosing a lagoon. The highest point is 828 metres at Piton de la Petite Rivière Noire. The climate is tropical to subtropical, with an average annual rainfall of 2,100 mm subject to strong variations. Rodrigues Island lies approximately 560 km east of Mauritius. The island is surrounded by coral reefs which form a lagoon about double its surface area (200 km^2) and contains 18 islets. Rodrigues has the largest caves and limestone deposits of the Mascarene Islands. It has a maritime tropical climate with an average annual rainfall of 1,120 mm.

In 2016, the total population of the RoM was 1.268 million with a growth rate of about 0.1% per year[1]. Over the next 10 years, population growth is expected to stabilise at replacement levels or less, but as population density in Mauritius is already high at 600 people per km^2, the predicted modest population growth will increase pressures on land use. The country was ranked 63th on the Human Development Index in 2014, with life expectancy at birth of 74.4 years and an adult literacy rate of 89.2%.

Over the last three decades the Mauritian economy has been regarded as a success story, with annual growth rates of over 5 % for many years and a per capita income of US$ 19,480 in 2015 (World Bank data). The country is listed 15th in the 2016 Economic Freedom global ranking (1st in Sub-Saharan Africa). The RoM is amongst the top group of upper middle-income countries and was ranked 46th in the Global Competitiveness Index 2015–2016 (1st in Sub-Saharan Africa).

Despite external headwinds, especially sluggish growth in the Euro Zone on which Mauritius is highly dependent for tourism, trade and foreign direct investment, the economy grew by 3.5% in 2015, similar to the 3.4% pace in 2014. Growth continues to be supported by tourism, information and communications technology and the financial and insurance sectors, which grew by 8.6%, 6.9% and 5.2%, respectively (World Bank data). In contrast, the construction sector shrank for a second consecutive year (by 4.3%) and textile value-added also declined by 1%.

According to the World Bank (2016 data[2]), Mauritius' main socio-economic challenges include: increasing competitiveness through greater regional integration, creating a stronger environment for innovation, making growth more inclusive by addressing a scarcity of skilled human resources, and bolstering resilience to natural disasters and climate change.

1.1 Values of biodiversity and ecosystem services in the Republic of Mauritius and their contribution to human well-being

Mauritius and Rodrigues form part of the Mascarene Islands located in the Western Indian Ocean, one of the 25 internationally recognised biodiversity 'hotspots' (Figure 1.2). The tropical climate, topography and over a million of years of isolation have resulted in the evolution of a diverse biota with a high degree of endemism (Table 1.1). A more comprehensive presentation of the knowledge on the biodiversity status, trends and threats of these islands is included in the Fifth National Report on the Convention on Biological Diversity (RoM, 2015). In this section, we briefly summarise the key points to consider for the NBSAP.

[1] Statistics Mauritius, accessed on January 10, 2017, at URL: http://statsmauritius.govmu.org/English/Publications/Pages/Pop-and-Vital_Stats_Jan-Jun16.aspx

[2] Accessed on January 10, 2017, at URL: http://www.worldbank.org/en/country/mauritius/overview

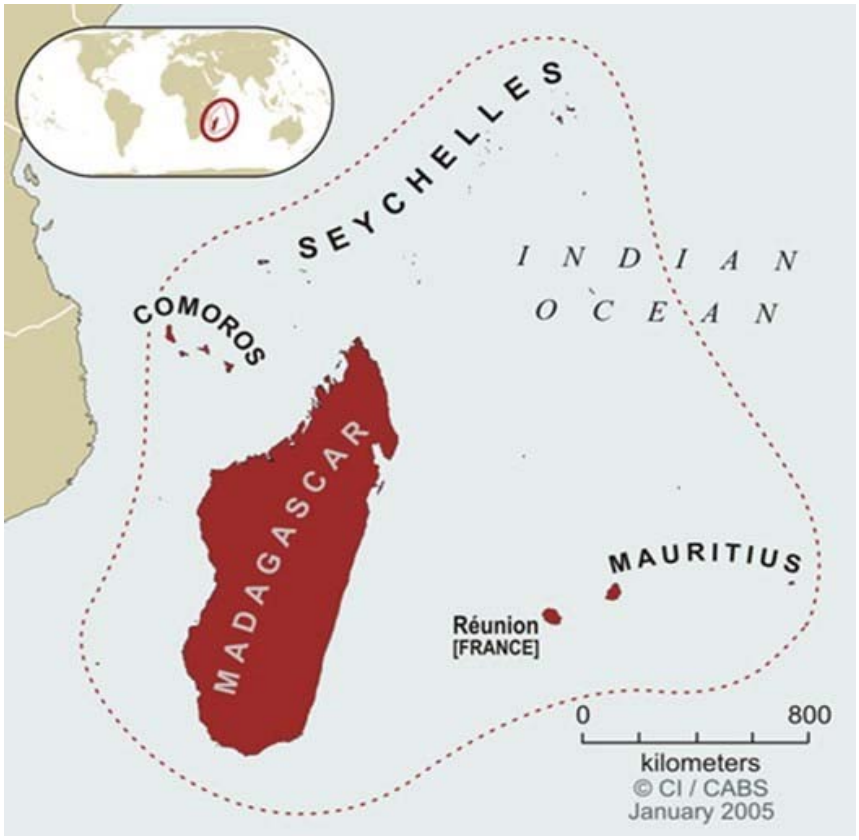

Figure 1.2: Location of the Madagascar and Indian Ocean Islands Hotspot (CEPF 2014)

Table 1.1 summarises the terrestrial fauna diversity, Table 1.2 the terrestrial floral diversity and Table 1.3 the status and trends of threatened bird species in Mauritius and Rodrigues.

Table 1.1: Terrestrial fauna species diversity (native and endemic, extinct and extant) in selected groups in Mauritius and Rodrigues

Mauritius						
Species Group	Total Native species	Endemic species	Extinct species	Endemic Extinct species	Existing species	Endemic Existing species
Mammals (Bats)	5	1	2	-	3	1
Land Birds	28	19	16	12	12	7
Reptiles	17	16	5	5	12	11
Butterflies	30	5	4	1	26	4
Snails	125	81	43	36	82	45

Rodrigues						
Species Group	Total Native species	Endemic species	Extinct species	Endemic Extinct species	Existing species	Endemic Existing species
Mammals (Bats)	2	-	1	-	1	-
Land Birds	14	13	11	11	3	2
Reptiles	8	8	8	8	-	-
Butterflies	10	-	1	-	9	-
Snails	30	16	7	5	23	11

(Source: adapted from Florens, 2013: MAIFS 2015)

Table 1.2: Terrestrial floral diversity of Mauritius and Rodrigues (MAIFS 2015)

Species Group	Total Native species	Endemic species	Extinct species	Endemic Extinct species	Existing species	Endemic Existing species
Mauritius	691	273	61	30	630	243
Rodrigues	150	47	17	10	133	37

Table 1.3: Evolution of populations of some threatened bird species from 2000 to 2016

Species/Year	2000	2009	2012/2013	2016	Trend 09-16
Mauritius Kestrel	700 birds	+/- 500 birds	362 birds	350 birds	Decrease
Mauritius Cuckoo-shrike	300 - 350 pairs	>350 pairs	NA	100 – 250 birds	Decrease
Mauritius Black Bulbul	225 - 340 pairs	225 - 340 pairs	NA	900 birds	Increase
Pink Pigeon	400 birds	+/- 400 birds	410 birds	350 – 400 birds	Decrease
Echo Parakeet	120 birds	440 birds	550 birds	650 – 700 birds	Increase
Mauritius Fody	100 – 125 pairs	160 birds IAA	35 birds IAA	240 – 330 birds BRGNP, 200 birds IAA	Increase
Mauritius Olive White-eye	<100 pairs	100 pairs	181 birds IAA	180 – 270 birds BRGNP, 56 birds IAA	Decrease
Mauritius Paradise Flycatcher	250 pairs	251 pairs	NA	800 birds	Increase

(Source: Unpublished report, MWF 2016)

Important Bird Areas and Key Biodiversity Areas in the RoM:

An Important Bird and Biodiversity Area (IBA) is an area identified using an internationally agreed set of criteria as being globally important for the conservation of bird populations. Currently there are over 12,000 IBAs worldwide. Birdlife International has designated sixteen Important Bird Areas for the Republic of Mauritius (Table 1.4; BirdLife International 2017).

Table 1.4: Important Bird Areas in the Republic of Mauritius

Site name	IBA Criteria	Final Code
Black River Gorges National Park and surrounding areas	A1, A2	MU002
Cargados Carajos Shoals	A4i, A4iii	MU016
Chamarel - Le Morne	A1, A2	MU001
East Coast Mountains	A1, A2	MU005
Flat and Gabriel Islands	A1	MU011
Gunner's Quoin	A1	MU010
Macchabé - Brise Fer Forest	A1, A2	MU003
Mauritius South-Eastern Islets	A1, A2	MU009
Moka Mountains	A1, A2	MU008
Plaine des Roches - Bras d'Eau	A1, A2	MU006
Pont Bon Dieu	A1, A2	MU007
Relict Forests of the Central Plateau	A1, A2	MU004
Rodrigues Islets	A4iii	MU015
Rodrigues Mainland	A1, A2	MU014
Round Island	A1, A4ii, A4iii	MU012
Serpent Island	A4i, A4iii	MU013

Key Biodiversity Areas (KBAs) are nationally identified sites of global significance. The identification of KBAs is an important approach to address biodiversity conservation at the site scale: i.e. at the level of individual protected areas, concessions and land management units. KBAs are identified using globally standardised criteria and thresholds, and have clearly defined boundaries. 17 KBAs have been identified for the Republic of Mauritius (CEPF 2014): one in St Brandon, three in Rodrigues Island and thirteen in the Island of Mauritius. The KBAs of the Island of Mauritius are:

- MUS-9 Le Pouce - Anse Courtois - Pieter Both – Longue Mountain;
- MUS-12 Black River Gorges National Park and surrounding areas, including Bassin Blanc / Mount Cocotte;
- MUS-11 Corps de Garde Mountain;
- MUS-17 Yemen-Tatamaka;
- MUS-2 Bambou Mountain Range;
- MUS-4 Tamarind Falls / Mount Simonet / Cabinet Nature Reserve;
- MUS-3 Chamarel - Le Morne;
- MUS-10 Mondrain - Magenta - Trois Mamelles - Mont du Rempart;
- MUS-8 Mauritius South Eastern Islets;
- MUS-7 Mauritius Northern Islets (Gunner‘s Quoin, Flat and Gabriel Islands, Round Island and Serpent Island;
- MUS-14 Plaine des Roches – Bras d‘Eau;
- MUS-5 Relict Forests of the Central Plateau, including Les Mares, Gouly Pere and Bois Sec;
- MUS-15 Pont Bon Dieu.

1.1.1 Island of Mauritius and its islets:

1.1.1.1 Terrestrial biodiversity status, threats and trends:

Before its discovery by the Portuguese in 1507, Mauritius supported a rich biodiversity, but is now sadly famous as the former home of the flightless Dodo (*Raphus cucullatus*), the very symbol of species extinction. There were no terrestrial mammals which aided the evolution of a number of flightless birds and large reptile species. The arrival of man saw extensive habitat loss and degradation and the introduction of invasive alien species (IAS).

Over 100 species of plants and animals have become extinct due to anthropogenic pressures (primarily IAS and habitat clearance) and many more are threatened. The Dutch East India Company first began to clear forest to exploit the ebony and palms in the lowlands, a process which accelerated markedly during the later French and the British administrations to make room for agriculture, roads and settlements (Figure 1.3; Table 1.5). The cleared forest areas were planted with sugar cane, tea, eucalyptus and pine, among other exotic species.

Today, Mauritius retains 691 indigenous plant species of which 273 are single island endemics and another 150 are Mascarene endemics (Baider *et al.*, 2010). The only native mammals are bats. There are currently 9 extant endemic bird and 11 extant endemic reptile species. Less than 2% of the native forest (good quality native forest) that once stretched from the mountain tops of the central plateau to the shore now remains, concentrated in the Black River Gorges National Park in the south west, the Bambou Mountain Range in the south-east and the Moka-Port Louis Ranges in the north-west. There are also some isolated mountains which are of biodiversity importance, e.g. Corps de Garde, and Le Morne Brabant, and several offshore islands with remnants of coastal and mainland biodiversity (CEPF 2014).

Today, agriculture remains the primary land use in Mauritius (Figure 1.3) and land is largely privately owned. State land is distributed throughout the island and the Government-owned Pas Géométriques, a narrow belt of land 81.21 m (250 French feet) around the coast. Vacant land for development is limited since most of the useable land has already been put to productive use. Of a total land area of 185,600 ha (Table 1.5), 53% is devoted to agriculture, 25% to forests (both plantations and natural forests) and 8% to settlements. As further shown in Table 1.5, the most forested districts, in terms of percentage of surface area, are Plaines Wilhems (31% forested), Port Louis (24% forested) and Savanne (20% forested). The “other land use” category (mostly shrubs) is prominent in the Black River (58% of surface area), Port Louis (43% of surface area) and Moka (34% of surface area) districts.

Table 1.5: Shares of major land use classes by district in Island of Mauritius (Source: Fischer *et al.* 2013)

District	Cultivated land (%)			Forest (%)	Other land (%)	Settlement (%)	Inland water bodies (%)	Total (000 ha)
	Total	Irrigated	Rain-fed					
Rivière du Rempart	73	60	13	0	18	9	0	17.2
Pamplemousses	65	46	18	3	21	10	1	17.7
Flacq	63	56	7	5	26	6	0	31.7
Port Louis	3	3	0	24	43	30	0	4
Black River	30	7	23	10	58	2	0	24.6
Plaines Wilhems	26	23	3	31	18	23	2	18.5
Moka	48	43	5	11	34	5	2	23
Grand Port	70	62	7	5	17	8	0	25.9
Savanne	60	50	10	20	17	3	0	23
Mauritius	53	43	10	11	27	8	1	185.6

Table 1.6: Land cover and land cover change in Mauritius, 2004-2014

	2004		2014		
Cover Class	Extent km^2	Share %	Extent km^2	Share %	Change %
Lagoons	10.8 ±3.1	0.57 ±0.16	10.8 ±3.1	0.57 ±0.16	0
Forests Other	64.5 ±7.6	3.52 ±0.40	64.5 ±7.6	3.52 ±0.40	0
Forests Mangroves	0.07 ±0.00	0.00 ±0.00	0.07 ±0.00	0.00 ±0.00	0
Forests Broad leaves	369.8 ±16.4	19.7 ±0.9	369.8 ±16.4	19.7 ±0.9	0
Forests Needle leaves	94.3 ±8.97	5.00 ±0.5	94.3 ±8.97	5.00 ±0.5	0
Cropland Sugarcane	630.3 ±19.4	33.5 ±1.03	616.1 ±19.4	33.1 ±1.03	-2.4
Cropland Trees	88.0 ±8.7	4.67 ±0.5	88.0 ±8.7	4.67 ±0.5	0
Cropland Tea	2.64 ±1. 6	0.14 ±0.08	2.60 ±1.6	0.14 ±0.08	-1.5
Cropland Other	193.8 ±12.6	10.4 ±0.7	196.5 ±12.6	10.4 ±0.7	1.8
Wetland trees	16.2 ±3.8	0.86 ±0.20	16.2 ±3.8	0.86 ±0.20	0
Wetland water bodies	20.7 ±4.8	1.10 ±0.2	20.7 ±4.3	1.10 ±0.2	0
Grassland Trees	3.59 ±1.8	0.19 ±0.10	3.59 ±1.8	0.19 ±0.10	0
Grassland others	14.2 ±3.8	0.86 ±0.2	16.2 ±3.8	0.86 ±0.20	0
Settlement Trees	88.0 ±8.7	4.67 ±0.5	87.1 ±8.6	4.62 ±0.5	-0.3
Settlement buildings	57.5 ±7.1	3.05 ±0.4	62.3 ±7.2	3.14 ±0.4	8.3
Settlement Roads	40.4 ±5.96	2.14 ±0.3	42.2 ±6.09	2.24 ±0.3	4.5
Settlements Others	92.5 ±8.89	4.90 ±0.47	97.2 ±9.05	5.10 ±0.48	5.1
Other land trees	36.8 ±5.69	1.95 ±0.30	36.8 ±5.69	1.95 ±0.30	0
Other lands others	52.6 ±6.80	2.81 ±0.36	53.0 ±6.80	2.81 ±0.36	0.8

(Source: Sookun, Boojhawon and Rughooputh – work in progress: Modelling ecosystems based land cover and land use in relation to carbon emissions and sequestrations).

Note: the values are shown as estimated in the GIS, together with their respective confidence limits

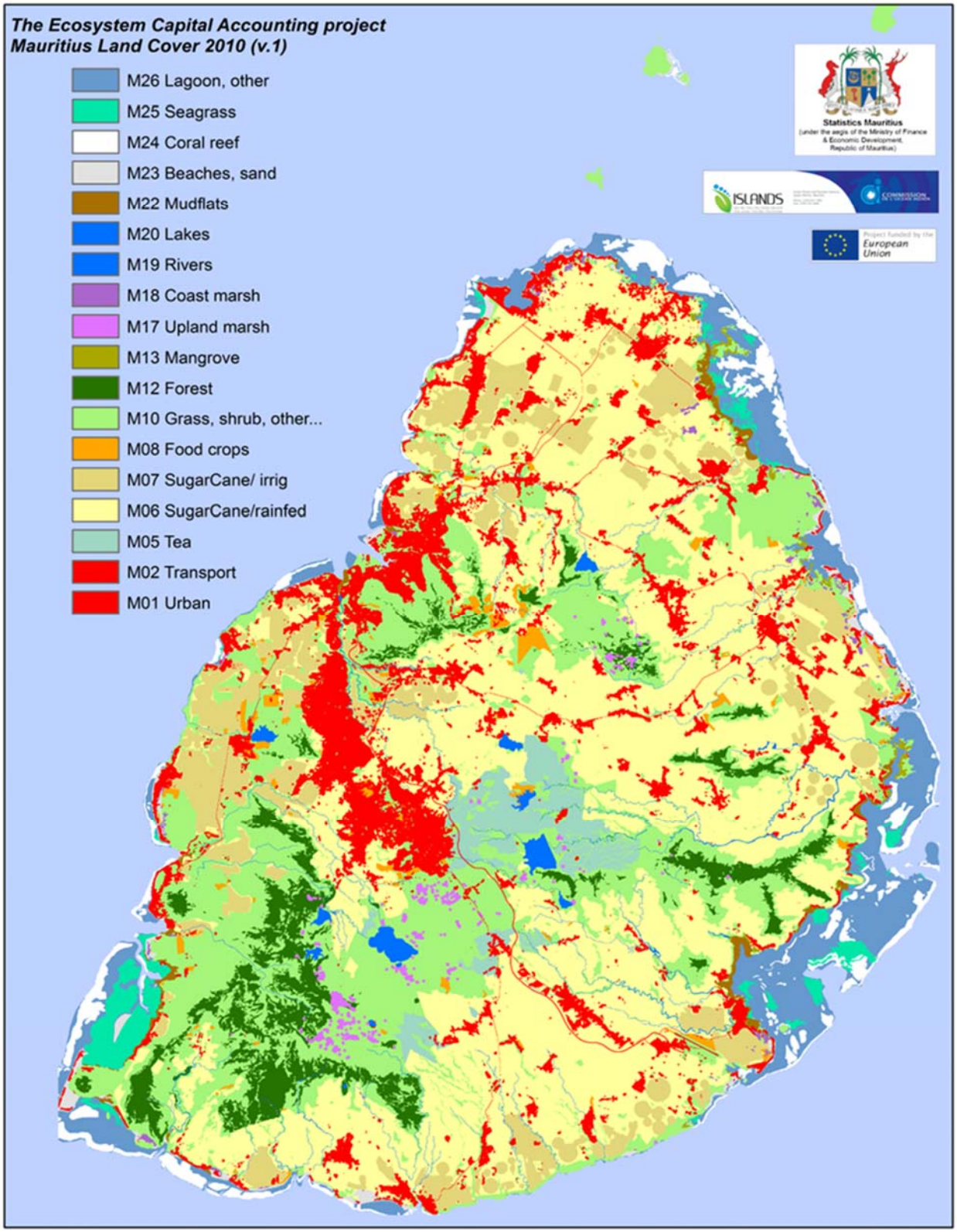

Figure 1.3: Land use in Mauritius (Weber 2014)

Table 1.6 shows that sugarcane areas have decreased by about 2.4% from 2004 to 2014 and tea areas by 1.5%, while other cropland areas have increased by 1.8%, urbanised areas have increased by 8.3%, roads by 4.5% and other settlements by 5.1%.

These figures show that terrestrial ecosystems have been largely transformed in Mauritius, and are under ongoing pressures, especially from IAS. This presents particular conservation and restoration challenges for the country.

Currently, the formal State Protected Area Network amounts to approximately 4%[4] of the surface area of Mauritius (Figure 1.4) and most of it is degraded by past land uses and IAS. Rehabilitation and restoration efforts for both inland terrestrial and freshwater habitats and species therefore form a major part of achieving Aichi Target 11 (Protected Areas increased and improved). Although it is estimated that less than 2% of the remaining native vegetation cover is in good condition (CEPF 2014), there is broad consensus that the Protected Area Network (PAN) in its present form is not representative of all habitat types in Mauritius and does not adequately protect all species and/or the critical ecosystems required to maintain the ecological integrity of Mauritius' ecosystems. Indeed, species and native habitat outside of the PAN remain under threat from both IAS and development pressures, problems that are experienced in other countries in the world. Institutional overlap in the management of the various PA types, as well as limited funding and skills, also hamper effective protected area management (MAIFS 2017a, draft document).

It is estimated that 25,000 ha of forested land is privately owned, or leased to private landowners. Much of this forest is managed for deer hunting with clearings for pasture. Some of the private land is classified as Mountain Reserve or River Reserve and receives legal protection. Mountain Reserves occupy the upper third of mountains. River Reserves vary in width from 8-16 m on each side, depending the size of the river. Deforestation is not permitted in these reserves but enforcement needs to be improved. There is little active conservation management of privately-owned forests apart from one private reserve on the land of Medine Sugar Estate comprising 5 hectares and managed by Mauritian Wildlife Foundation (leased to the Royal Society of Arts and Sciences of Mauritius until August 2013, when it was then leased to MWF for 20 years). There are also some innovative forest restoration projects associated to the development of nature-based tourism (e.g. Vallée de Ferney, Bel Ombre, Case Noyale and Ebony Forest). It has thus been concluded that:

- Management of protected areas needs to be strengthened; and
- Protected areas need to be expanded to be representative of all ecosystem types.

In response, the Government of Mauritius (GoM), with support from the United Nations Development Programme (UNDP) and funding from the Global Environment Facility (GEF), launched the project 'Expanding coverage and strengthening management effectiveness of the protected area network on the Island of Mauritius' ('PAN Project'). The overall objective of the Project is to expand protected area coverage and to strengthen the management effectiveness of the existing PAs (MAIFS 2017b, draft document). It further seeks to restore critical areas of biological significance and to maintain and improve ecosystem functions.

The potential PAN currently being identified includes all areas that have some form of protection and covers 16%, slightly below that of Aichi Target 11 (17%). This PAN must also be expanded further, primarily to private land falling outside the current PAN and by filling in gaps between PAs, in order to better represent the various ecosystem types in Mauritius (MAIFS 2017c, draft document).

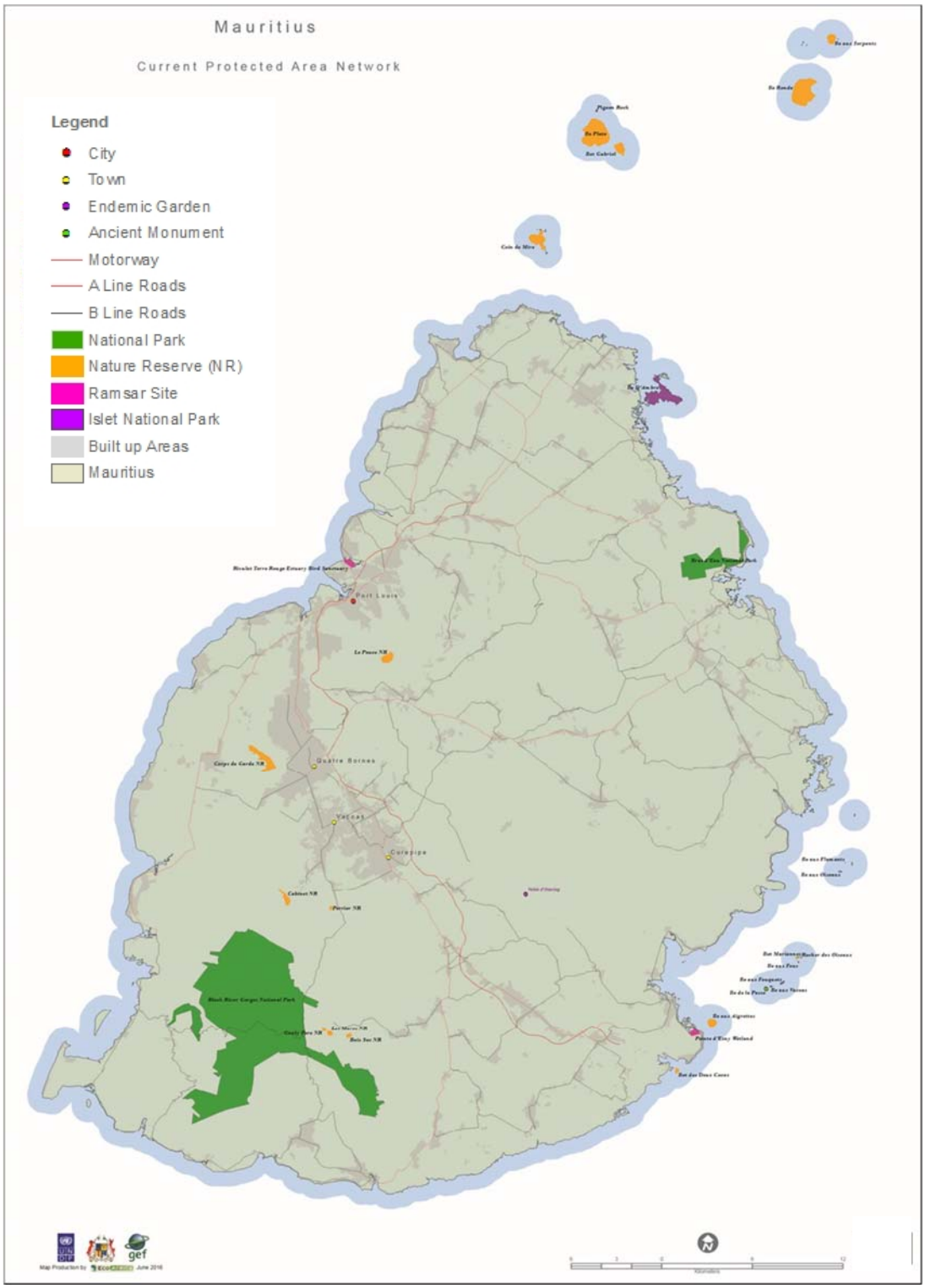

Figure 1.4: Current Protected Area Network of Mauritius including National Parks, Nature Reserves and Ramsar Sites (MAIFS 2017c, draft document)

For the PAN expansion to proceed in an efficient manner, and within the context of Mauritian specificities, a carefully thought out and commonly agreed upon strategy is needed. The PAN Project is trying to bring all relevant stakeholders together in the implementation of the Protected Area Network Expansion Strategy (PANES) (MAIFS 2017b, draft document). However, fulfilling an expanded PAN will require innovative mechanisms and actions, especially on privately owned and leased lands.

1.1.1.2 Status of inland freshwater, coastal and marine biodiversity:

Mauritius has diverse wetland ecosystems, from freshwater wetlands and rivers to mangroves and coral reefs (Figure 1.5). Inland freshwater ecosystems have been largely transformed, and coastal and marine ecosystems are under significant anthropological pressures.

Inland rivers and wetlands:

The Island of Mauritius is divided into 25 major river basins and 21 minor ones with catchment areas varying from 3.9 to 173 km^2 (MAIFS 2015). Almost all major rivers are perennial with most of the streams having their sources in the central plateau. Flows rates vary from a few litres per second to more than 500 m^3/s during floods. Wetlands in Mauritius can be divided into natural (e.g. coastal marshlands such as tidal mudflats and mangroves, inland freshwater rivers and marshlands, marine wetlands such as coral reeds and seagrass beds) and artificial wetlands (reservoirs, dams, canals) (MESD 2009; Figure 1.5).

According to a recent review (Landell Mills Consortium, 2015), there are 31 species of fish and 11 species of crustacean (1 extinct, 4 endemics), of which 33 are native. There are also 26 species of dragonflies (7 endemics), 26 species of water beetles, 30 species of aquatic beetles and 19 molluscs (2 of which are possibly extinct).

A few permanent water bird species are recorded, including the dubiously native Common Moorhen (*Gallinula chloropus*), the Green Heron (*Butorides striata*), the recently introduced invasive Egyptian Goose (*Alopochen aegyptiacus*), and two other recently introduced and establishing duck species - Mallard (*Anas platyrhynchos*) and Whistling Ducks (*Dendrocygna viduata*). Migratory species include the Common Whimbrel (*Numenius phaeopus*) (some individuals may be sub-migratory), terns, plovers, sandpipers, turnstones, greenshanks; some 15 to 20 annual migratory species, in addition to uncommon visitors and rare vagrants.

In addition, there are 3 known introduced freshwater turtles; The Chinese Softshell Turtle (*Pelodiscus sinensis*), Eastern African Black Mud Turtle (*Pelusios subniger*), and the Red-eared Slider (*Trachemys scripta elegans*), and two introduced amphibian species, the Guttural Toad (*Bufo gutturalis)* and the Mascarene Ridged Frog (*Ptychadena mascareniensis*) (Cole 2008).

Coastal and marine ecosystems:

The coastline of Mauritius is 322 km long and almost entirely surrounded by a fringing coral reef enclosing a lagoon area of 243 km^2. There are three designated Ramsar Sites of International Importance in Mauritius[3], the Rivulet Terre Rouge Estuary Bird Sanctuary (declared in 2001), the Blue Bay Marine Park (declared in 2008), and the Pointe d'Esny Wetland (declared in 2011). The coral reef of St Brandon covers an area of 190 km^2, while Agalega has 100 km^2. Mauritius' EEZ (Figure 1.6) covers approximately 2.3 million km^2. Mauritius also exercises jurisdiction jointly with Seychelles over 396,000 km^2 of Extended Continental Shelf in the Mascarene Plateau Region (Joint Management Area).

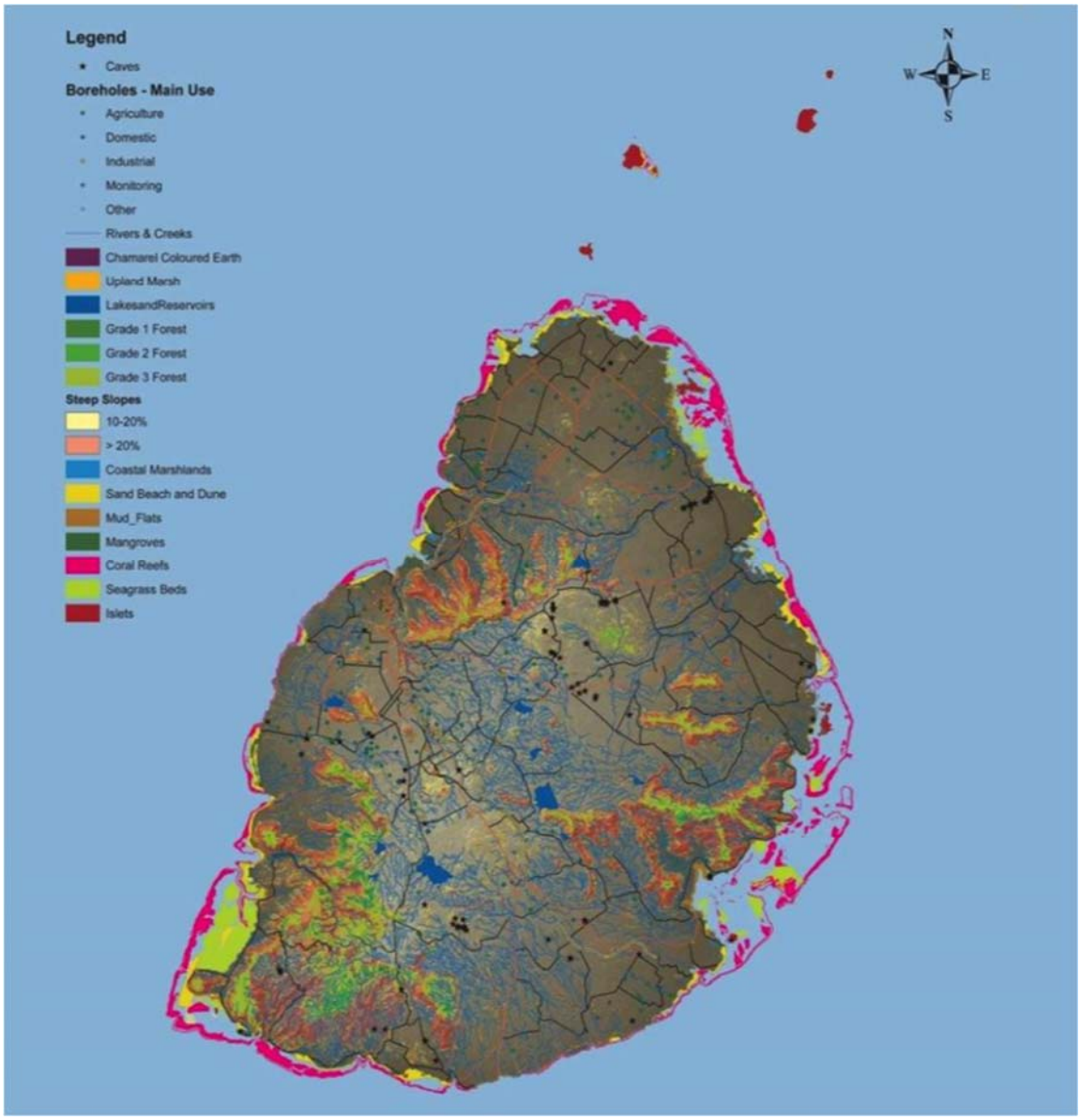

Figure 1.5: Demarcation and inventory of wetlands in Mauritius (MESD 2009)

[3] *URL: http://www.ramsar.org/wetland/mauritius*

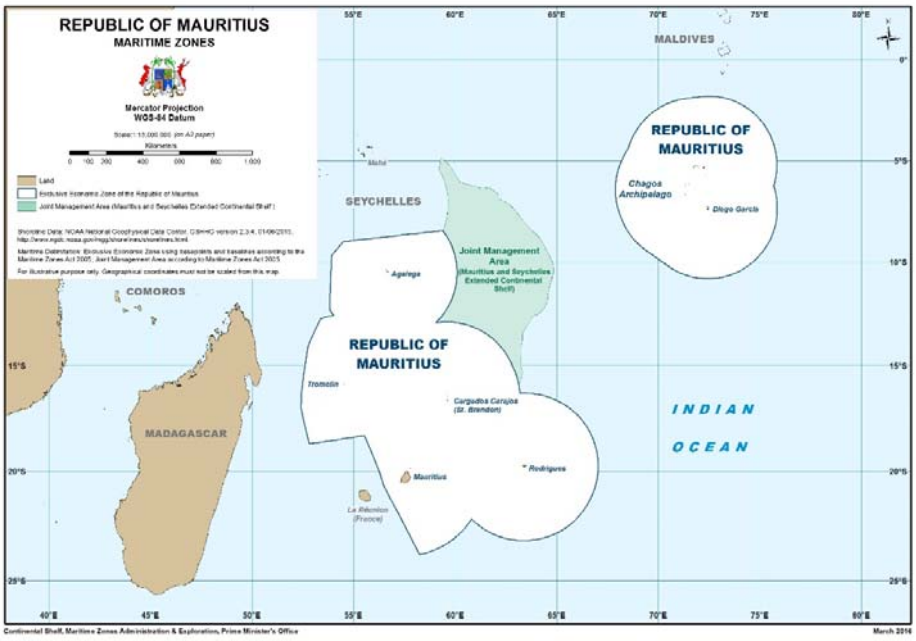

Figure 1.6: Republic of Mauritius and its EEZ (Source: DCSMZAE)

Marine Protected Areas for mainland Mauritius cover an extent of 7,190 hectares, including six fishing reserves and two marine protected areas (Castro de la Mata 2012). The lagoon and sea (up to 1 km from the high-water mark line) surrounding the 8 islets in the Islet National Parks also forms part of the Islet National Park. This accounts for an area about 36 km^2.

Work on marine biodiversity lags far behind that carried out in terrestrial ecosystems. According to Mauremootoo *et al.* (2003), much of the marine biodiversity found in Mauritian waters consists of common Indo-Pacific species that constitutes common biota for biotopes such as sea grass beds, coral reef, mangroves, sandy, muddy and rocky shores. For instance, there are four types of reef around Mauritius: fringing reefs, patch reefs, atolls and barrier reefs, with the Mauritian offshore islands of St Brandon including a group of 22 atolls. Marine species diversity is very high with about 1,656 species in 290 families having been recorded, with 159 species of scleractinian corals (hard corals). As Mauritius is a remote island high levels of endemism can be expected.

The economic and social importance of coastal and marine ecosystems is now widely recognised (RoM 2013, Sultan 2012). Out of 340 species of fish identified in the waters of Mauritius, 42 are of economic importance within the inshore area, with a different composition and relative abundance in the near shore waters of each island within the Republic. Several species of crabs, shrimps, lobsters, molluscs, octopus and sea cucumbers are also of commercial value. A recent DNA-based assessment of commercial fish diversity of Mauritius by the

Mauritius Oceanography Institute (MOI) found number 186 species of commercial fish, out of which 41 are new records to Mauritius and 3 may be potentially new species (MAIFS 2015).

Tourism, one of the main income-generating sectors of Mauritius, depends heavily on the quality and level of preservation of the coastal zone including its marine biodiversity. Yet, several studies confirm various anthological impacts on habitats and species, including beach erosion, water pollution and the overexploitation of marine resources (Baird 2003).

1.1.1.3 Status of agro-biodiversity:

In Mauritius, agro-biodiversity is directly linked to historical biodiversity loss (habitat clearance to create new agro-ecosystems for food production) as crops and animals have been introduced since the first settlements in the seventeenth century. Accordingly, many of the current crops grown and animals reared have evolved for decades, if not centuries, in the local agro-ecosystems, hence generating local varieties and breeds which now constitute the agricultural biodiversity of Mauritius.

Until the 1970s, the Mauritian economy was predominantly agricultural and based on sugar cane production. Since then, the contribution of agricultural production to GDP has been declining steadily from around 30% to only 3.4% in 2013, largely as a result of the successful diversification of the economy into the manufacturing and services sectors (MAIFS 2016a). 2.2% is generated by the sugar subsector. Agriculture provides direct employment to some 44,200 persons.

Nearly 54,000 ha of agricultural land was devoted to sugar cane production in 2013, with about 8,200 ha under food crops and 700 ha under tea (ibid). Incidentally, 2 ha of tobacco were also produced, but this commodity has now been phased out completely. Normally self-sufficient in vegetables, Mauritius is a net food importer, and imports close to 77% of its food requirements. Imported agricultural products were valued at MUR 36.4 billion compared just over MUR 23.6 billion for exports. Main imports include wheat, rice, oil, fresh fruits, meat and milk. Over the last 5 years, the import-export gap has been rising, indicating an increasing dependency on imported food (ibid).

The native flora contains only one species that is regularly exploited (*Dictyosperma album*) and three members of one genus (*Coffea* spp.) that has yielded economically important crops elsewhere. Two of these *Coffea* species (*Coffea macrocarpa* and *C. myrtifolia*) are endemic to Mauritius, while the third, *C. mauritiana*, is also found in Réunion. These species are known to be naturally caffeine-free and could thus be of great importance in developing low caffeine cultivars (Dulloo 1998). The endemic Palmiste Blanc (*Dictyosperma album* var. *album*) is cultivated in plantations on marginal lands for its palm cabbage. This local trade is estimated to be worth 20 million rupees (Govinden 2004). In the past, the cabbages were exported, but the trade has stopped as local demand from hotels and restaurants exceeds supply.

Although they are not native, several wild relatives of important crops have become naturalised in Mauritius. Among others, these include tomato (*Lycopersicon esculentum* var. *tallerelli*), pigeon pea (*Cajanus cajan*), potato

(*Solanum commersonii*), *Solanum torvum* (white flowers) and *Solanum indicum* (violet flowers). An interesting species, Lentille Créole (*Vigna glabrescens*), is believed to be unique. It is found in the Pamplemousses Garden and is extensively used in the development of fusarium wilt-resistant beans. Seeds are stored in the Vigna Collection at Gembloux, Université Agricole, Belgium. Local livestock breeds, notably Creole cattle and local goats, continue to exist to some extent in Mauritius.

1.1.2 Rodrigues Island and its islets:

1.1.2.1 Terrestrial biodiversity status:

Situated 619 km to the east of Mauritius, Rodrigues Island is hilly with a central spine culminating in its highest point, Mont Limon (393 m). Rodrigues is the only Mascarene Island with extensive limestone deposits and caves. The island is in the cyclone belt and has a warm wet season from November to April and a cool dry season from May to October (MAIFS 2015).

In contrast to the Island of Mauritius, 90 % of the land in Rodrigues is state-owned. Rodrigues has retained a predominantly agrarian and fishing-based economy (land use illustrated in Figure 1.7). Crop farming, livestock rearing and lagoon fishing are the main economic activities on the island (MAIFS 2015). Rodrigues is characterised by a drier climate than Mauritius and frequently faces droughts, which affect agricultural production. Planted forest cover is estimated at around 30 % of the Rodrigues land area (pers. comms., Rodrigues Forestry Service and MWF 2016).

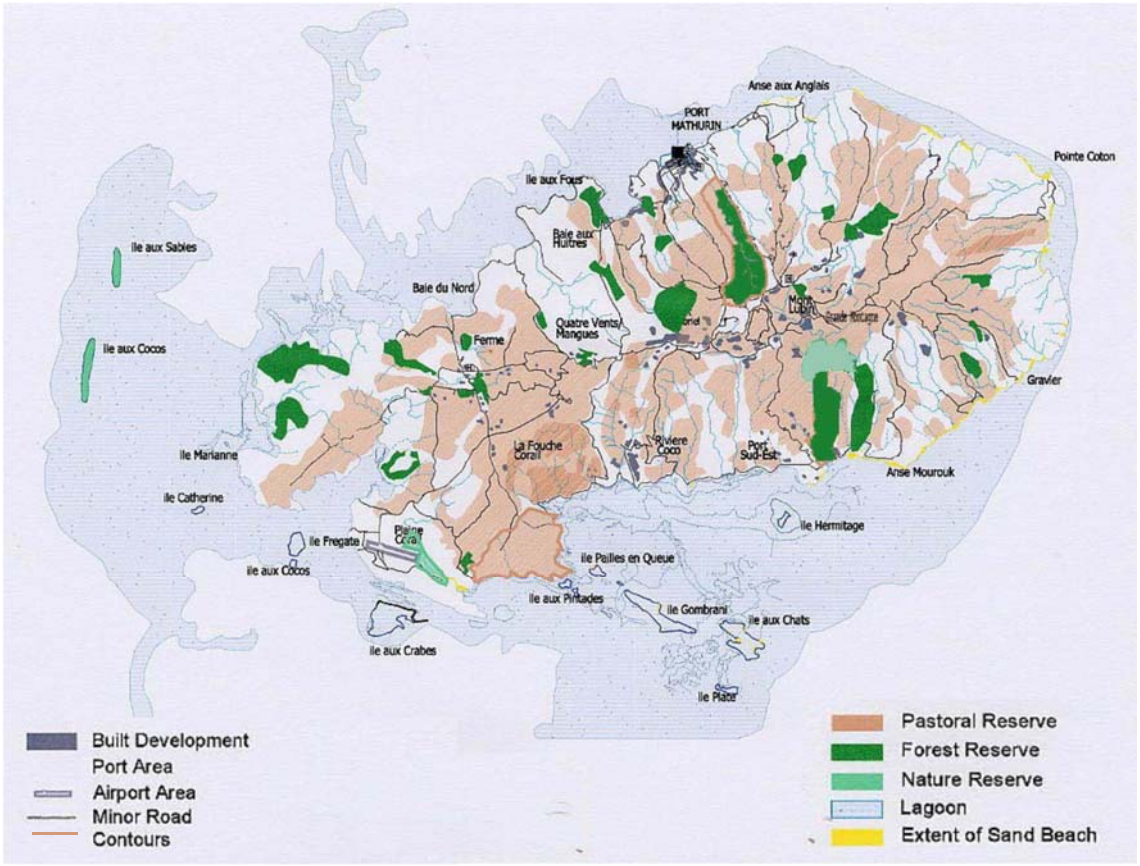

Figure 1.7: Rodrigues land use map (MAIF 2005)

Rodrigues hosts 150 indigenous plant species, of which 47 are single island endemics, and 72 are Mascarene endemics (Baider *et al*., 2010). The detailed accounts of Francois Leguat (1708), a self-exiled Huguenot on Rodrigues, from the late 17th Century paint an idyllic picture of valleys covered with palm-trees, screwpines and ebonies. Leguat was a keen naturalist and gave a precise description of the island's biodiversity, including the Solitaire (*Pezophaps solitaria*), Red Rail (*Aphanapteryx leguati*), Giant Gecko (*Phelsuma gigas*) and tortoises (*Geochelone* spp.).

Rodrigues is one of the most degraded tropical islands in the world, and much of the terrestrial biodiversity is extinct, or highly threatened. Invasive alien woody species (including *Vachellia nilotica* – widely known by its synonym *Acacia nilotica*) dominate all forest areas on Rodrigues and, with the exception of intensively restored areas in the nature reserves, no contiguous areas of native forest exist (pers. comms., MWF 2016). Nine Rodrigues endemic plant species comprise of less than 10 mature individuals in the wild, including three, which are known from just a single individual in the wild (*Ramosmania rodriguesii, Dombeya rodriguesiana* and *Gouania leguatii*) (MWF 2012).

Rodrigues formerly held at least twelve species of endemic bird, two species of giant tortoise, two species of giant gecko, two species of night gecko, an unidentified lizard and one endemic fruit bat. Of these vertebrates, only four species remain; the Rodrigues Warbler (*Acrocephalus rodricanus*), the Rodrigues Fody (*Foudia flavicans*), the Rodrigues Fruit Bat (*Pteropus rodricensis*), and the native Mourning Gecko (*Lepidodactylus lugubris*) (MAIF 2005).

The remaining native plants and animals are scattered across the landscape. For example, Cascade Mourouk contains the last remaining individual of *Gouania leguatii* and two individuals of *Hibiscus liliflorus.* The valley of Anse Quitor is equally important for lowland plants. Some plant species are restricted to single islets (e.g. *Myoporum mauritianum* on Ile Gombrani). The two islets of Ile aux Sables (8 ha) and Ile aux Cocos (14.4 ha) harbour breeding sites for many sea birds, especially the Fairy Tern (*Gygis alba*), Brown Noddy (*Anous stolidus*), Lesser Noddy (*A. tenuirostris*), and sooty tern (*Sterna fuscata*). Ile aux Cocos is home to the native Mourning Gecko, a population of *Pisonia grandis* (Bois Mapou) and an endemic beetle (*Cratopus inornatus*).

Terrestrial biodiversity plays a key part in the livelihoods of many people. The collection of leaves of the endemic Vacoas (*Pandanus heterocarpus* and *P. tenuifolius*) for mats, hats, baskets and handicrafts is an important, though as yet unquantified, economic activity (MAIF 2005). Several endemic species are noted for their medicinal properties and those that are common, e.g. Bois Gandine, *Mathurina penduliflora*, and Affouche à Petites Feuilles, *Ficus reflexa*, are still used regularly; Gurib-Fakim *et al.,* 1994). Of the remaining endemic plant species, there is one particular example of possible agronomic importance, the Latanier Jaune (*Latania verschaffeltii*) which has edible fruits and its leaves are used in thatching and handicrafts.

BirdLife International has designated two Important Bird Areas in Rodrigues, namely MUS 014 (Rodrigues mainland) and MUS 015 (Rodrigues islets). Furthermore, the Critical Ecosystems Partnership Fund has designated three Key Biodiversity Areas for Rodrigues (CEPF 2014):

- MUS-16 South Slopes of Grande Montagne, which includes Grande Montagne Nature Reserve and Mourouk/Cascade Victoire;
- MUS-13 Plaine Corail which includes Anse Quitor Nature Reserve and Plaine Corail/Cascade St Louis and the Francois Leguat Reserve; and
- MUS-6 Rodrigues' Islets which covers South Islands Reserves (Ile Gombrani / Ile aux Crabes, etc.), Ile aux Cocos, Ile aux Sables, Ile aux Fous (North of Rodrigues).

1.1.2.2 Status of inland freshwater, coastal and marine biodiversity:

In Rodrigues, the marine ecosystem is in better condition than in Mauritius but under increasing pressures through climate change and coral bleaching, and overfishing (pers. comms., MWF 2016; MAIFS 2015). Among measures being implemented to mitigate pressures affecting the marine environment is the setting up of the South East Marine Protected Area (SEMPA), funded by UNDP/GEF/RRA under the project "Partnerships in Mauritius and Rodrigues for Marine Protected Areas." The project covered a total area of 43 km² and has led to the designation of 4 new marine reserves in the north of the island at Grand Bassin (14.1 km^2), Passe Demi (7.2 km^2), Passe Cabri (1.5 km^2) and Rivière Banane (1.5 km^2) following consultations with fishing communities.

Inland rivers and wetlands:

The island of Rodrigues has been divided into 20 major river basins and 10 minor ones, all of which have been significantly transformed by human activities. There are only three permanent rivers (Mourouk, Cascade Pigeon, Cascade Victoire) and the only standing fresh water is found in caves and wells. There has never been an assessment of freshwater biodiversity in Rodrigues (MAIF 2005).

Coastal and marine ecosystems:

In contrast to Mauritius, a large fringing reef surrounds Rodrigues (with reef flats). This forms a lagoon within which lie eighteen small islets. Indeed, Rodrigues has the most substantial and best-developed reefs in the Mascarenes, and the coral reefs are amongst the best preserved in the Western Indian Ocean (diving and snorkelling provides an important source of revenue). Rodrigues has a coral reef platform that forms an almost continuous rim, 90 km long and from 50 to 10,000 metres wide which encloses a lagoon of 240 km^2. Rodrigues has 493 fish species, 175 gastropod species, 104 species of algae, 109 bivalve species, 138 coral species, 74 species of echinoderms and 41 bryozoan species. For many of the taxa considered, Rodrigues appears to be less diverse with the notable absence of certain species common elsewhere in the area (MAIFS 2015).

There are about 2,000 registered fishers in Rodrigues, fishing mainly in the lagoon areas, because of the investment required for the acquisition of specialised fishing vessels for offshore fishing (MAIFS 2015). The most common fishing methods are nets (legal minimum mesh size of 9 cm), basket traps (made of bamboo or iron

mesh), reef gleaning (primarily for octopus) and line fishing. There is also some sport fishing in the lagoon, and big-game fishing offshore. For Rodrigues, the total fish catch increased between 2010 and 2013 by 68 % of which fish caught in the lagoon made up to 94 %, while off-lagoon fishing decreased by 19 %.

1.1.2.3 Status of agro-biodiversity:

Some 2,500 hectares of land are suitable for systematic agriculture and pasture. Like Mauritius, the genetic diversity of all cultivated crop species and reared livestock in Rodrigues originates from past introductions (MAIFS 2015). Some of the cultivated crops, however, have naturalised wild relatives (e.g. *Ananas bracteatus* - Ananas Marron - and *Solanum indicum* - Bringelle Marron). Local varieties have also been developed through local practices and, although most have been displaced by introduced modern high yielding varieties, some are still used. These include two landraces of bean (*Phaseolus vulgaris*) - the local red and the navy beans. Rodrigues is also known for its Petit Piment (chilli pepper), the local onion (Toupie), and the Rodriguan lime.

Maize (*Zea mays*) has been an economically important crop since the 18th Century and there have been periodic introductions from several sources including America, Europe and Africa (MAIFS 2015). Following quarantine laws in 1940, introductions were restricted and farmers started selecting locally. These ecotypes are still cultivated even after the recent introduction of hybrids.

Local breeds of cow, pig, goat, sheep and poultry used to exist, although high levels of outcrossing with introduced breeds make it difficult to find the pure Rodriguan forms anymore (MAIFS 2015). Native grass species can still be found in pasture (e.g. *Cynodon dactylon* - Chiendent, *Paspalum commersonii* - Herbe à Epée, *Stenotaphrum dimidiatum* – Herbe Bourrique), although species introduced accidentally and deliberately, for erosion control, now dominate.

1.2 Analysis of the causes and consequences of biodiversity loss

As outlined in the NBSAP 2017 – 2025 preparatory study "Advances in cross-sectoral mainstreaming of biodiversity in Mauritius" (MAIFS 2017d), much still needs to be done towards meeting the country's CBD obligations (Article 6a) and providing a strategic approach for biodiversity management for the coming decade (2017 –2025). This study presents an in-depth discussion of the interdependency links between biodiversity, ecosystem services and several sectors (agriculture, marine, tourism and water) and topics (land use management, food security and renewable energy). Stakeholder interests, potential partnerships and conflicts, as well as possible win-win scenarios are also explored.

The following are among its key findings: Stakeholders are aware of the importance of natural capital, but the lack of understanding of the diverse values of nature is preventing them from addressing the underlying causes of biodiversity loss. Mainstreaming biodiversity across government and society requires natural capital / ecosystem assessment, monitoring, valuation and reporting systems for both the public and private sectors, addressing perverse subsidies, developing and implementing new production models and educating all stakeholders and citizens.

To effectively reduce the direct pressures on biodiversity, restore biodiversity and natural habitats, improve the status of threatened species and genetic diversity, maximise ecosystem services delivery to all, and promote knowledge sharing, significant resources will have to be secured and invested for the long term. While partnerships with both international donors and the private sector should be sought, it is also important to recognise that proactive changes in existing practices can bring about significant benefits towards pro-biodiversity development pathways for the country.

Biome / Ecosystem type	Threats	Drivers of threats							Implications
		Direct Drivers				Indirect Drivers			
Forest and terrestrial	Reduction/loss in habitat posing the risk of loss of species	Habitat degradation	IAS	Pollution	Climate change	Demographic change	Socio-Political Factors	Funding capacity, knowhow limitations & other factors	Ecosystem integrity and functioning affected. May affect inland tourism activities
Forest and terrestrial	Reduction/loss in habitat posing the risk of loss of species	↗	↗	↘	↑	↗	→	→	Ecosystem integrity and functioning affected. May affect inland tourism activities
Agricultural	Loss of PGR	↗	↗	↘	↑	→	↗	↗	Loss of traditional knowledge and loss of important genetic resources. Adds risks to food security which is a growing concern.
Inland waters, marine & coastal	Degradation / Loss of habitat with potential loss of species	↗	↗		↑	↑	→	→	Impacts on ecosystem good and services, local livelihoods affected.

↑	Increase	↗	Moderate increase	↘	Moderate decrease	→	Unchanged / under control

Figure 1.8: Summary of threats to biodiversity in Mauritius and Rodrigues (MAIFS 2015)

Finally, given Mauritius' highly threatened biodiversity and seriously degraded natural capital stocks, it is critical that all stakeholders change their perspective from one focused on preserving the little that is left to one based on restoring (even creating) natural capital through new forms of development and innovation (MAIFS 2017d).

A comprehensive presentation of the causes and consequences of biodiversity loss is included in the Fifth National Report on the Convention on Biological Diversity (RoM, 2015). Figure 1.7 summarises threats to biodiversity in Mauritius and Rodrigues with its implications for ecosystem services and the economy. While climate change, habitat degradation and IAS are the major threats to the remaining terrestrial biodiversity (indigenous habitats very limited in extent, high densities of IAS, and numerous threatened species); coastal and marine ecosystems, though in better condition, are under severe threats from both marine and land-based activities, including agriculture, industry and urbanisation.

Coral reefs and sea grass beds are being damaged by coastal development, sedimentation, marine pollution, anchor damage and pollution from inland activities (Landell Mills Consortium, 2015; RoM 2009). Though

expanded tourism activities have provided considerable direct and indirect employment, they have also led to the rapid construction of hotels and other facilities along the shoreline, hence leading to habitat losses and increasing disturbances to coastal and marine ecosystems (Mamoun *et al.*, 2013). For instance, backfilling of wetlands for construction is affecting many wetlands and resulting in a surface reduction of natural habitats.

Table 1.7: Summary of threats to biodiversity and ecosystem services for coastal, freshwater & marine ESA

ESA type	Threats and threat drivers	Impact of loss of ESA type on ecosystem services
Mangroves	Although mangrove loss has declined, habitat fragmentation and land use conversion still threaten this ESA type, due to growing demand for land for development in prime coastal areas.	Loss of mangroves results in reduction in coastal storm protection, leading to increased coastal erosion, and loss of fish nursery services that negatively impacts the fishing sector. Where mangroves have been cleared, sediments are not properly filtered leading to high rates of soil runoff into lagoon areas, increasing turbidity which reduces sunlight which affects overall lagoon productivity.
Sandy beaches and dunes	Threatened by erosion, due to inappropriate seashore construction altering currents and flow, combined with sea level rise; invasive alien species, inappropriate construction (in many places the setbacks for construction is not being respected).	Loss of species dependent on dunes and loss of recreational services as both tourists and local people value sandy beaches for this purpose; In addition, beach erosion results in remedial measures to protect tourism and residential developments which further acerbates the problem. Native coastal forest has been lost and replacement by alien Casuarina trees is a major contributor to coastal erosion.
Coral reefs	Reef trampling and careless anchoring practices damage coral. Land-use change upstream results in increased sedimentation, affecting turbidity and water chemistry and oxygen levels in the lagoon, which all affect corals and other reef life. More frequent and extensive incidents of coral bleaching as a result of sea warming due to climate change. Increase in the frequency and strength of tropical storms and sea level rise. Increased CO_2 concentration in the ocean causes acidification of the water, affects calcareous marine species. Reef resources, including fish, octopus and crustaceans, are overexploited in many areas	The loss of the recreational value of reefs has a direct bearing on tourism; sports fishing and diving depend on the health of marine life within lagoons and another incident of coral bleaching could have a pervasive impact on tourism. Overfishing will reduce fish stocks/populations, and the diversity of useful fish species, negatively affecting livelihoods that depend on fishing. Damage to coral reefs reduces their ability to protect shorelines, and results in increased coastal erosion (reef damage is already thought to be contributing to coastal erosion at Albion and Flic en Flac)
Coastal wetlands	Backfilling linked to the expansion of the built environment; invasive alien species, pollution and sedimentation; conversion to other land uses.	Loss of coastal wetlands in Mauritius is known to be contributing to increased incidences and intensity of flooding as their water storage capacity is being reduced; their capacity to filter sediment and waste waters is also significantly reduced. Loss of wetlands also threatens a number of endemic plants found along the margins of marshlands.
Intertidal mud flats and sea grass beds	Land-based pollution from increased economic activities causes eutrophication and hypoxia of both mud flats and sea grass beds; erosion of steep slopes and lack of imposition of soil retention measures causes sedimentation. Eutrophication and hypoxia, affects all key functions of marine life, adding a very strong stressor to the lagoon environment, which directly depend on sunlight and oxygen for life cycle functions. If excessive, as seen, it breaks	Pollution disrupts natural ecological relationships and resilience, with considerable costs to the economy: fishing may be suspended due to fish die-off or toxic algae invasion, and beaches may have to be closed. Seagrass beds will cease to capture carbon and will no longer play their part in the marine food chain. The sediment deposition function which is essential is also immediately lost.

ESA type	Threats and threat drivers	Impact of loss of ESA type on ecosystem services
	down resilience and creates 'dead zones' -- e.g. in the area around Port Luis, where the marine ecosystems entered into total collapsed and became too simplified and too poor in biomass. Excess sediment in lagoons is most severe around river mouths and can be seasonally critical (e.g. during the rainy season). Anchoring also damages sea grass beds. Coastal development and infilling, and the development of water front residential and tourism infrastructure and marinas is also damaging or removing many areas of mud flat and sea grass bed	

(Source: UNDP – RoM – GEF, 2016)

Because the coastal zone, inshore and offshore waters of the RoM are of vital importance for socio-economic development, protecting the island from the natural forces of the ocean, providing income through tourism and fisheries, and as the focus of many leisure and other activities (MAIFS 2015), increasing pressures from sea and land-based activities threatens to prevent the full socio-economic potential of the country from being realised, as well as the long term goal of creating a sustainable ocean economy (RoM 2013).

1.3 National constitutional, legal and institutional framework:

The Government of Mauritius initiated conservation actions in the early 1970's, when at the invitation of the Government Sir Peter Scott wrote a report entitled "Conservation in Mauritius". This was the forerunner to IUCN's Conservation in Mauritius (1974) by John Proctor and Rod Salm which took into account the forest policy and the general environment laws that existed at the time, as well as the work in place to protect terrestrial and marine environments. There are many policies, strategies, plans, laws, international conventions, regional partnerships / agreements and institutions related to biodiversity issues in the RoM. The most significant ones are described in the following sections.

1.3.1 International Conventions, Agreements and Co-operation

1.3.1.1 International Conventions

Mauritius was among the first countries in the world to ratify the Convention on Biological Diversity in 1992. The Ministry of Agro-Industry and Food Security is the focal point for the Convention as well as for technical bodies, such as the Subsidiary Body on Technology and Technical Advice, and for protocols, such as the Nagoya Protocol on Access and Benefit Sharing (ABS).

The Government of Mauritius is also signatory to a number of International Conventions relating to the CBD (Table 1.8). These include:

- The Convention on Biological Diversity (1992) and its associated Protocols, the Cartagena Protocol on Biosafety (2000) and the Nagoya Protocol on Access and Benefit-Sharing (2012);
- The Nairobi Convention and the Protocol for the Protection of the Marine and Coastal Environment of the Western Indian Ocean from Land-Based Sources and Activities (2010);

- The African Convention for the Protection of Nature and Natural Resources (1968);
- The Convention on Fishing and Conservation of Living Resources of the High Seas (1958);
- The Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar) (1971);
- The Convention for the Protection of the World Cultural and Natural Heritage (1972);
- The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (1973);
- The UN Convention on the Law of the Sea (UNCLOS) (1982);
- The Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (MARPOL) (1989);
- The UN Framework Convention on Climate Change (UNFCCC) (1992);
- The UN Convention to Combat Desertification in Africa (UNCCD) (1995);
- The Convention on Migratory Species (1994);
- The International Convention for the Regulation of Whaling (1946);
- The African Eurasian Water Bird Agreement (1999);
- The Indian Ocean – South-East Asia Marine Turtle MOU (IOSEA) (2003).

Table 1.8: Ratification dates for Multilateral Environmental Agreements

MEAs	Ratification status	Focal Ministry
African Convention for the Conservation of Nature and Natural Resources (Algiers Convention)	Signed: Sep 1968	MOEMRFS
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	Ratified: Apr 1975	MAIFS
Convention on Biological Diversity (CBD)	Ratified: Sep 1992	
Bonn Convention on Migratory Species (CMS)	Ratified: Jan 2001	
Cartagena Protocol on Biosafety	Acceded: Apr 2002	
International Plant Protection Convention (1971); Revised text (1990)	Acceded: Jun 1971	
Convention on Wetlands of International importance especially as Waterfowl Habitat (Ramsar 1971)	Ratified: May 2001	
African-Eurasian Water-bird Agreement (AEWA)	Signed: Sep 2002	
International Plant Protection Convention (1971); Revised text (1990)	Acceded: Jun 1971	
United Nations Convention to Combat Desertification (UNCCD)	Ratified: Jan 1996	MSSNSESD
Convention on the High Seas (1958)	Acceded: Oct 1970	MOEMRFS
Convention on Fishing and Conservation of the Living Resources of the High Seas 1958		
Convention on the prevention of pollution from Ships of 1973, as modified by the Protocol of 1978 (MARPOL 73/78)	Acceded: Apr 1995	
1992 Civil Liability Convention CLC and Fund Convention	Acceded: Dec 2000	
Convention on Civil Liability for Bunker oil pollution, 2001	Acceded: Oct 2013	
Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage 1971 and Protocol of 1976	Acceded: Apr 1999	
Agreement for the Establishment of the Indian Ocean Tuna Commission (IOTC) adopted in 1983	Signed: Nov 1993	
Protocol on preparedness, response and cooperation to pollution incidents by hazardous and Noxious Substances,2000 (OPRC-HNS Protocol)	Acceded: Oct 2013	
Jakarta Mandate on Marine and Coastal Biological Diversity	Adopted: 1998	
Agreement on the Organisation for Indian Ocean Marine Affairs	Ratified: Jul 1992	PMO
Convention on the Territorial Sea and Contiguous Zone 1958	Acceded: Oct 1970	
Convention on the Protection, Management and Development of the marine and coastal environment of the Eastern African Region and related protocols (Nairobi Convention 1985)	Acceded: Jul 2000	MSSNSESD
Convention on the Prohibition of Military or any other Hostile Use of Environmental Modification Techniques 1977	Acceded: Sep 1992	PMO
Convention for the Protection of the World Cultural and Natural Heritage 1972	Ratified: Sep 1995	MAC

1.3.1.1 Regional strategies and plans

Mauritius has received GEF funding for a number of biodiversity-related projects. Financial and technical assistance has also been received under initiatives such as Darwin (UK), Millennium Seed Bank (UK), and from the European Union. Funds, equipment and training were also provided to the Plant Genetic Resources (PGR) Unit of MAIFS by the Southern African Development Community's (SADC) Genetic Resource Centre.

Mauritius is also active in mainstreaming recommendations of major international sustainable development conferences (such as Agenda 21, Barbados Programme of Action for the Sustainable Development of Small Island Developing States, the Johannesburg Programme of Implementation, Mauritius Strategy, Rio+20 Outcome Document and Samoa Outcome) into national decision-making,

At the regional level, policies are also being developed which will contribute to the management, conservation and protection of biodiversity, including the:

- SADC Regional Biodiversity Strategy and the Regional Indicative Strategic Development Plan[4];
- The Indian Ocean Commission with the support from EU for the Biodiversity Programme which includes the Regional Strategy paper 2008-2013 for Eastern & Southern Africa and the Indian Ocean 2014 – 2020 and the Regional Indicative Programme for Eastern Africa, Southern Africa and the Indian Ocean;
- The Common Market for Eastern and Southern Africa (COMESA) Forest situation, value, prospects and strategy for its development.

1.3.2 National legislation:

Mauritius has, over the years, developed a number of laws related to biodiversity conservation and management, mostly within the framework of natural resources management, inclusive of the sustainable utilisation of its components.

1.3.2.1 The National Development Strategy and its related enactments

The National Development Strategy (NDS) provides the basis for land use planning. It was approved in 2003 and subsequently given legal force through the proclamation of the relevant section of the Planning and Development Act in June 2005. In September 2006, the policies and proposals of the NDS were successfully translated at the local level through the preparation and approval of local development plans (commonly known as Outline Planning Schemes).

The Planning and Development Act 2004 provides an updated framework for land use planning and decision making at national and local levels. A series of Planning Policy Guidance (PPG) have been prepared to assist developers, Local Authorities and the general public in complying with principles of appropriate design, site

[4] *Available at: http://www.sadc.int/issues/environment-sustainable-development/biodiversity/*

identification and location of activities. Further monitoring of the plans are being undertaken to keep them up to date and in line with present socio-economic objectives (MESDDBM 2011).

1.3.2.2 The Environment Protection Act (2002)

The Environment Protection Act 2002, as amended in 2008, provides for control over land use planning and development through the Environmental Impact Assessment (EIA) and Preliminary Environmental Report (PER) mechanisms. EIA and PER enable project promoters take into consideration environmental issues at the stage of conception and planning. It also allows developers to compare alternative technologies and adopt pollution prevention and control strategies.

1.3.2.3 The Forests and Reserves Act (1983)

The purpose of the Forests and Reserves Act (Act. No. 41 of 1983), together with its amendments, serve towards the administration and management of forest resources. The Forests and Reserves Act No.41 of 1983 has been amended by the Forests and Reserves Act 2003 (Act No.7 of 2003), Government Gazette No.46 of 24 May 2003, to make provision for control of access to nature reserves[5]. Sixteen Nature Reserves have been selected (two of which now form part of the National Park, and 4 are in Rodrigues) for the purpose of maintaining vegetation cover and for the provision of ecosystem services.

1.3.2.4 Strategic Plan (2016 - 2020) For the Food Crop, Livestock and Forestry Sectors:

The overall goal is to raise national food security levels by maintaining self-sufficiency in those agricultural products where it is possible and by generating a significant, concomitant increase in local production of others. This will be achieved through a shift to sustainable agricultural practices and using methods of production and protection that are eco-friendly and conducive to safer and better human nutrition.

In line with Government's vision for bio-food, bio-farming including permaculture and other variants will be promoted. This would require a drastic change in farmers' mindset vis-à-vis agrochemicals. The following measures are proposed:

- Sensitisation of the public on the importance of consuming bio-food, and valuing the difference;
- Development of bio-production protocols;
- Establishment of dedicated bio-farming zones, and the relevant conditions to be imposed on land use and crop management;
- Training of farmers in production of bio-food production;
- Introduction of a bio-farming certificate /label to encourage bio-food production.

[5] *URL: http://forestry.govmu.org/English/Pages/default.aspx; http://agriculture.govmu.org/English/Pages/The-Forest-And-Reserves-Act-1983.aspx*

1.3.2.5 Native Terrestrial Biodiversity and National Parks Act 2015

The Native Terrestrial Biodiversity and National Parks Act (NTBNPA) 2015 replaced the Wildlife and National Parks Act 1993. The main object of this NTBNPA is to make further and better provision for the protection, conservation and management of native terrestrial biodiversity, and giving effect to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and any other biodiversity related Convention to which Mauritius is or may become a party[6]. The NTBNPA also provides for the identification, control and management of reserved lands and private reserves. It was felt that after more than 20 years and with major developments in the areas of biodiversity conservation and management, there was a need to further strengthen the protection of endemic fauna and flora and genetic resources. Mauritius is a signatory party and member of a number of biodiversity related international instruments and networks, namely: (a) CBD), (b) CITES, (c) the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilisation, (d) CMS, (e) the Ramsar Convention on Wetlands, (f) IUCN and (g) the African Eurasian Waterbird Agreement (AEWA).

With the introduction of the Native Terrestrial Biodiversity and National Parks Act 2015, freshwater biodiversity is within the ambit of the National Parks and Conservation Service. However, there is still a lack of technical capacity to manage freshwater biodiversity, which needs to be addressed in a practical and pragmatic way.

Up until end 2015, there was no institution with the mandate to overview and coordinate the management of the freshwater biodiversity. It was spread through many institutions as summarised in Table 1.9 (Landell-Mills Consortium 2015).

[6] *URL: http://mauritiusassembly.govmu.org/English/hansard/Documents/2015/hansard3515.pdf*

Table 1.9: Fragmented responsibilities over the management of freshwater resources

	Hydro power	Mgmt water resources	Water quality	Water rights	ICZM	Import permit	Aqua-culture	Freshwater biodiversity	Wetlands	Pollution reduction	Maintaining ecosystem services	Healthy riparian zone
Min of Environment								X	X	X	X	X
Water quality std.			X							X		X
NEL			X							X		
ICZM unit					X					X		X
Disaster unit											X	X
Min of Energy		X										X
WRU		X		X								
CWA		X	X	X				X		X		
CEB	X							X				
Min of Health								X		X		
Parasites monitoring			X								X	
Min of Ocean					X			X	X		X	
Aqua-culture							X					
Import license						X						
AFRC			X		X				X	X	X	X
MAIFS					X				X	X	X	X
NPCS								X			X	
Herbarium								X				
FAREI										X		
Irrigation auth.										X	X	
NIASC						X		X				
NRAC								X	X			
Agro Industry				X						X	X	
Other business activities			X									
Invasive Issues	X	X	X		X		X	X	X	X		

1.3.2.6 Other relevant legislation

Biodiversity conservation, management and sustainable use has been integrated in most legislations and associated policies, strategies and action plans over the last decades, including the agriculture, tourism and fisheries sectors. Examples of such laws include: Plant Protection Act (2006), Fisheries and Marine Resources (Removal of Corals and Shells) Regulations (2006), Tourism Act (2004). Here is comprehensive list of relevant pieces of legislation.

Legislation on the Coastal and Marine Environment

- Primary Legislation:
  - Beach Authority Act 2002;
  - Central Water Authority Act 1971;
  - Environment Protection Act 2002 as Amended in 2008;
  - Fisheries and Marine Resources Act;
  - Maritime Zones Act 2005;
  - Merchant Shipping Act 1986, as amended by the Merchant Shipping (Amendment) act 1992;
  - National Coast Guard Act 1988;
  - Ports Act 1998;
  - Removal of Sand Act 1982 and Removal of Sand (Amendment) Act 1997.
- Subsidiary legislation:
  - Beach Authority (Use of Public Beach) Regulations 2004;
  - Merchant Shipping (Civil Liability for Oil Pollution Damage and International Fund for Compensation for Oil Pollution Damage) Regulations 1996;
  - Port (Operations & Safety) Regulations 2005;
  - Ports (Operations & Safety) (Amendment) Regulations 2007.

Legislation on the Flora and Fauna

- Primary legislation:
  - Board of Agriculture and Natural Resources Act 1977;
  - Environment Protection Act 2002 as Amended in 2008;
  - Fisheries and Marine Resources Act;
  - Forests and Reserves Act 1983;
  - Maritime Zones Act 2005;
  - Plant Protection Act 2006;
  - Seed Act 2013;
  - GMO Act 2004;
  - Planning and Development Act 2004;
  - Shooting and Fishing Leases Act 1982;
  - The Native Terrestrial Biodiversity and National Parks Act 2015
- Subsidiary legislation:
  - Botanical Gardens (Pamplemousses) Regulations 1945;
  - Botanical Gardens Regulations 1922;
  - Female Sea Turtles (Prohibition of Import) Regulations 1950;
  - National Parks and Reserves Regulations 1996;
  - Plants (Importation and Exportation) Regulations 1976;
  - Plants (Pest and Disease Control) Regulations 1984;
  - Wildlife Regulations 1998.

Legislation on Fisheries and the Marine Environment

- Fisheries and Marine Resources Act 2007;
- Regulations:
  - Amendment of Schedule Regulations 2014 - (GN No. 68 of 2014);
  - Licence and Fees Regulations 2013 - (GN No. 288 of 2013);
  - Extension of Net Fishing Season Regulations 2013 - (GN No. 226 of 2013);
  - Export of Fish and Fish Products (Amendment) Regulations 2012 - (GN No. 209 of 2012);
  - Bait Gear Licence And Licence Fees Regulations 2012 - (GN No. 214 of 2012);
  - Extension of Net Fishing Season Regulations 2012 - (GN No. 173 of 2012);
  - Import of Fish and Fish Products Regulations 2012 - (GN No. 27 of 2012);
  - Fishing of Sea Cucumbers (Amendment)Regulations 2012 - (GN No. 18 of 2012);
  - Extension of Net Fishing Season Regulations 2011 - (GN No. 175 of 2011);
  - Prohibition of the Use of Hooks of Small Size Regulations 2011 - (GN No. 128 of 2011);
  - Export of Fish and Fish Products (Amendment) Regulations 2010 - (GN No. 204 of 2010);
  - Extension of Net Fishing Season Regulations 2010 - (GN No. 196 of 2010);
  - Export of Fish and Fish Products Regulations 2009- (GN No. 147 of 2009);
  - Extension of Net Fishing Season Regulations 2009 - (GN No. 111 of 2009);
  - Fishing of Sea Cucumbers Regulations 2009 - (GN No. 110 of 2009);
  - The Fishing of Sea Cucumbers Regulations 2008 - (GN No. 189 of 2008);
  - Prohibition of Removal of Coral and Sea-shell Regulations 2006 - (GN No. 95 of 2006);
  - The Undersized Fish Regulations 2006 - (GN No. 54 of 2006);
  - Vessel Monitoring System Regulations 2005 - (GN No. 87 of 2005);
  - The Toxic Fishes Regulations 2004 - (GN No. 193 of 2004);
  - The Marine Protected Areas Regulations 2001 - (GN No. 172 of 2001);
  - Amendment of Schedule Regulations 2014 - (GN No. 68 of 2014);

1.3.3 National policies, strategies and plans

Mauritius has, over the years, developed a number of national policies, strategies and plans related to biodiversity conservation and management, mostly within the framework of natural resources management, inclusive of the sustainable utilisation of its components.

1.3.3.1 The National Conservation Strategy

In 1985 the Government of Mauritius published a White Paper for a "National Conservation Strategy" (NCS), in which it defined the major objectives for the conservation of natural resources based on the same objectives as the World Conservation Strategy, namely:

(i) to maintain essential ecological processes and life support systems;

(ii) to preserve genetic diversity, on which depend the breeding programmes necessary for the protection and improvement of cultivated plants and domesticated animals, as well as for scientific advancement;

(iii) to ensure the sustainable utilisation of species and ecosystems, for example, fish and other wildlife, forests and grazing lands.

Priorities to attain the above aims and objectives included:

- Avoiding extinction of endangered and threatened species of flora and fauna by providing sound planning, allocation and management of land and water use, supported by an on-site preservation in protected areas and an off-site protection such as zoos and botanical gardens;
- Preserving as wide a genetic diversity as possible of many varieties of the same plants and animals;
- Preserving as many habitats as possible;
- Expanding large conservation management areas to other key biodiversity hotspots areas, and
- Encouraging the protection of wetlands and river reserves.

1.3.3.2 National Environmental Policy

The National Environmental Policy (NEP) was first set out in a White Paper of 1990 with the objective to foster harmony between quality of life, environmental protection and sustainable development for the present and future generations. In combination with other policies, the following thematic sectors were covered: Forest biodiversity, terrestrial biodiversity, agro-biodiversity, freshwater, coastal and marine aquatic biodiversity, biotechnology and sustainable ecotourism. Progress in conservation of native flora has been made with support from NGOs, Government and foreign organisations. An Islets Management Plan was also produced in 2004 (RoM 2004).

1.3.3.3 National Environmental Action Plan

This first National Environmental Action Plan (NEAP 1) supported by the first Environmental Investment Programme (EIP 1) consisted of 32 projects and included terrestrial conservation. The outputs also included the establishment of the country's first National Park to conserve endangered species, integrated pest management research, management of nature reserves, offshore islets management, the proclamation of two marine parks, and the initiation of long term monitoring and research (First NBSAP 2006).

Following the NEAP 1, NEAP II - National Environment Strategies for the Republic of Mauritius was published as the NEAP for the next decade. It set out the national environment strategy, including the provision for an Environmental Impact Assessment (EIA) for several undertakings, thus incorporating biodiversity protection and conservation, among other issues.

1.3.3.4 The National Forestry Policy (2006)

The National Forestry Policy (2006) is a statement of the intentions of the GoM for the development of the forest sector and is designed to protect and enhance the country's natural environment, biodiversity and national heritage, while at the same time promoting recreation and tourism. This policy describes, in general terms, the directions that forestry activities should take in the coming decade to address identified issues and problems. It is also a guide for decision-making. Forestry policy formulation is a dynamic process that must be reviewed periodically in the light of a changing environment, society and globalisation of forestry.

1.3.3.5 Integrated Coastal Zone Management (ICZM)

The Integrated Coastal Zone Management (ICZM) Division was established in 2000 for the sustainable management of the coastal zone and its resources. Through its work, the Division aims to maintain a high quality coastal environment and conserve coastal and marine biodiversity. Its main activities are focused on the coordination with relevant Organisations on coastal zone management issues, monitoring of coastal erosion, and coastal protection works among others[7].

An ICZM Committee comprising of Ministries, parastatal bodies, NGOS and Private sector was established in 2002 under the Environment Protection Act (2002). The Committee meets regularly and coordinates activities within the coastal zone. In 2010, an ICZM Framework was developed including ICZM Action and Area Plans, ICZM Strategy, ICZM legislative and Policy Framework amongst others. Sub-committees were set up under the ICZM Committee for effective follow up. Fourteen Coastal Conservation plans have been developed, along with, a beach management plan and guidelines. Implementation of measures proposed are being followed up by ICZM Sub-committees.

1.3.3.6 National Biosafety Framework (1999)

A National Biodiversity Framework has been developed in 1999. It sets out guidelines for the 'safe development and introduction of Genetically Modified Organisms in Mauritius'. It recommends practises and procedures for the safe use of biotechnology to protect the environment and human and animal health from the potential adverse effects of GMOs.

1.3.3.7 Vision 2020

In 1991 the Government published a White Paper for the National Environment Policy providing a commitment to attaining sustainable development. The White Paper placed great emphasis on the duties of the individual in environmental protection and the concomitant right to relevant information, while aiming to safeguard prosperity, health and heritage. The policy was reviewed in Vision 2020 ("The National Long Term Perspective Study") creating the challenge of establishing a resource management approach that would involve the management of the entire ecosystem. This would be based on the modelling of interactions between the economy and the environment. The Vision 2020 sets out a scenario for future development based on:

- Gains in agricultural efficiency;
- High quality, high yield tourism;
- Quality and specialised industrial production, and
- Movement towards financial and value-added services.

[7] *URL: (http://environment.govmu.org/English/Department%20of%20Environment/Pages/Integrated-Coastal-Zone-Management.aspx*

1.3.3.8 2030 Agenda for Sustainable Development

This Agenda is a plan of action for people, planet and prosperity[8]. All countries and all stakeholders, acting in collaborative partnership, are expected to implement this plan. The 17 Sustainable Development Goals (SDG) and 169 targets demonstrate the scale and ambition of this new universal Agenda. They seek to build on the Millennium Development Goals and complete what these did not achieve. They are integrated and indivisible and balance the three dimensions of sustainable development: the economic, social and environmental. The Goals and targets will stimulate action over the next fifteen years in areas of critical importance for humanity and the planet.

At the 70th UN General Assembly held in September 2015, world leaders embraced the 2030 Agenda for Sustainable Development with new goals and targets set to transforming the world. Goal 15 specifically refers to biodiversity protection and reads as follows: protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation and halt biodiversity loss. A set of targets clearly spells out the need to take urgent and significant actions to reduce the degradation of natural habitats, halt the loss of biodiversity and protect and prevent the extinction of threatened species. There was also the need to introduce new measures to prevent the introduction of IAS and reduce their impact on land and water ecosystems and control or eradicate the priority species. Mauritius has undertaken active commitments to achieve the SDGs and special provisions have also been made to address biodiversity issues[9]. The Strategic Policy Unit (SPU) under the Prime Minister's Office (PMO) oversees the SGDs, while Statistics Mauritius compiles the indicators to monitor the progress on SDGs.

1.3.3.9 Sustainable consumption and production

Mauritius was the first country in Africa to develop its National Programme on Sustainable Consumption and Production (SCP), under the guidance of UNEP, to implement the 10-Year Framework of Programmes of the Marrakech Process. Adopted in 2008, the National Programme on SCP aspires to decouple economic growth from use of natural resources, bring a change in consumption patterns, promote technological shifts and encourage the adoption of more sustainable lifestyles.

Mauritius also participates in the SWITCH Africa Green Project, which represents a collaborative partnership between African Countries and the European Union to promote SCP and Green Economy. Projects to be implemented under the SWITCH Africa Green initiative will consist of 'greening' the manufacturing, agricultural and tourism sectors and capturing opportunities for resource efficient green goods and services and supporting local green entrepreneurs in starting up and developing green business ventures.

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[8] *URL: https://sustainabledevelopment.un.org/post2015/transformingourworld*

[9] *URL: http://www.govmu.org/English/News/Pages/Members-of-National-Assembly-discuss-the-2030-Agenda-for-Sustainable-Development.aspx*

1.3.3.10 The National Invasive Alien Species Strategy and Action Plan (2008 – 2017)

The National Invasive Alien Species Strategy and Action Plan (NIASSAP) for the RoM presents a vision in which the negative impacts of IAS on the economy, environment and society are avoided, eliminated or minimised. The Strategy serves as a guide to the nation so that all Mauritians are together responsible for avoiding, eliminating or minimising the negative impacts of IAS.

The NIASSAAP Management Elements, with their accompanying goal or goals are listed in order of priority based on the maxim that "prevention is better than cure", in line with CBD Guiding Principle 2.1.2:

1. Prevention - to minimise the number of unintended and intended IAS introductions to the RoM;
2. Early Detection and Rapid Response - to minimise the number of IAS that go on to have harmful consequences once they are introduced to the RoM;
3. Eradication - an agreed framework for eradication priorities in place, eradications undertaken as necessary and results disseminated;
4. Control and Management - to contain the distribution and abundance of IAS in the
5. Republic of Mauritius to a long-term acceptable level; and
6. Restoration - to undertake ecosystem restoration where necessary in the RoM to achieve long-term ecosystem goals.

Yet, the NIASSAP does not prioritise the actions discussed, does not clearly commit a lead agency to carry out each one, and there is no timeline nor estimate of resources required.

1.3.3.11 National Strategic Action Plan for the Conservation and Sustainable Use of Crop Wild Relatives (2016 – 2025)

The National Strategic Action Plan for the Conservation and Sustainable Use of Crop Wild Relatives (MAIFS 2016b) aims to protect and restore the Crop Wild Relatives (CWR) ecosystems for their conservation and sustainable use in the RoM. It focuses on awareness raising of the importance of CWR for food and economic security (including in the context of climate change), provides a framework and roadmap for their conservation and sustainable use and defines the specific actions and resources required for the latter.

1.3.3.12 Protected Area Network Expansion Strategy (2016 – 2026)

The Government of Mauritius, under the aegis of the Ministry of Agro Industry and Food Security (MAIFS), has initiated the Protected Area Network Expansion Strategy (PANES) under the PAN Project (Expanding coverage and strengthening management effectiveness of the protected area network on the island of Mauritius) (MAIFS 2017b). The project is co-funded by GEF through UNDP. During the development of the PANES over the last two years, four major areas of competency were identified that need to be developed and institutionalised:

- Conservation planning,
- Biodiversity stewardship,
- Nature-based tourism development, and
- IAS management.

1.3.3.13 Other relevant policies

In addition to the above, there are several others that also address biodiversity and natural resources, including:

- Strategic Plan (2016 - 2020) for the Food Crop, Livestock and Forestry Sectors;
- Multi-Annual Adaptation Strategy Sugar Sector Action Plan 2006-2015;
- Islets Strategic & Management Plans;
- The 5-year Fishery Development Plan;
- Fisheries - National Plan of Action to prevent, deter and eliminate illegal, unreported and unregulated fishing;
- Aquaculture Master Plan;
- National Environmental Strategies (1998);
- Climate Change Action Plan (1999);
- Tourism Development Plan (2002);
- National Development Strategies (2004);
- Islets National Park Strategic Plan (2004);
- National Action Program to Combat Desertification (2004);
- National Environment Policy (2007);
- National Environmental Strategies (2008);
- Environmentally Sensitive Areas Study (2009);
- National IAS Strategy and Action Plan (2010);
- National Forest Policy (2006);
- Second National Communication of the Republic of Mauritius under the United Nations Framework Convention on Climate Change (2010);
- Maurice Ile Durable (MID) Green Paper (2011);
- MID Working Group Report on Preservation of Biodiversity and Natural Resources (2011);
- Policy and Governance Assessment for Marine and Coastal Resources for the Republic of Mauritius (2011);
- National Climate Change Adaptation Policy Framework (2012) and
- Mainstreaming Climate Change Adaptation in the Agriculture, Fisheries, Tourism and Water Sector for the Republic of Mauritius (2012).

1.3.4 Institutions and stakeholders

Governmental agencies and institutions which have responsibilities for the protection and conservation of natural resources, including biodiversity, are listed below:

- National Park and Conservation Service of the Ministry of Agro Industry and Food Security;
- Forestry Service of the Ministry of Agro Industry and Food Security;
- Ministry of Social Security, National Solidarity and Environment & Sustainable Development;
- Ministry of Ocean Economy, Marine Resources, Fisheries and Shipping;
- Albion Fisheries Research Centre (AFRC) of the MOEMRFS;
- Mauritius Oceanography Institute (MOI) which falls under the purview of the Ministry of Ocean Economy, Marine Resources, Fisheries and Shipping.
- Ministry of Tourism.

In addition, the Native Terrestrial Biodiversity and National Parks Act 2015 has enacted several committees, including:

- The Native Terrestrial Biodiversity and National Parks Advisory Council which looks into matters related to native terrestrial biodiversity, reserved land, and conservation generally; the assessment of the state of wildlife resources and the effect of land use and environmental activities on wildlife and wildlife habitat; and any related matter referred to it by the Minister and make recommendations to the Minister with regard to the conservation of wildlife;
- The CITES Scientific Authority to advise the CITES Management Authority (NPCS Director) on any matter relating to CITES;
- The Invasive Alien Species Committee which looks into matters related to the introduction of exotic wildlife in Mauritius; request for the importation of invasive alien species, policies to be adopted for the control of invasive alien species and the preparation of a prohibited list of wildlife species which shall not be allowed to enter Mauritius;
- The Special Technical Committee for the purpose of controlling wildlife in Mauritius; and
- The National Parks and Conservation Fund Committee for the management of the fund.

There are also several environmental and biodiversity conservation NGOs, including (in alphabetical order):

- Biodiversity Action Group;
- Eco-Sud;
- Global Rivers Environmental Education Network (GREEN);
- International union for the Conservation of Nature (IUCN);
- Mauritian Wildlife Foundation (MWF);
- Mauritius Marine Conservation Society (MMCS);
- Reef Conservation Mauritius (RCM).

1.4 Lessons learned from the earlier NBSAP(s) and the process of developing the updated NBSAP

1.4.1 CBD implementation progress under the last NBSAP (2006 – 2015)

Since the Fourth National Report on the CBD (2010), Mauritius has taken a number of actions to support the Convention implementation. Policies and strategies for the conservation and sustainable use of biodiversity have been adopted and are at various stages of implementation, including the National Invasive Alien Species Strategy and Action Plan (2008 – 2017) and the ICZM Strategy, Legislative and Policy Framework (2010). The revision of legislation and regulation has also been undertaken, notably the enactment of the Native Terrestrial Biodiversity and National Parks Act (NTBNPA) 2015 which replaced the Wildlife and National Parks Act 1993. A full review of the NBSAP 2005 – 2006 achievements and limitations is available in the Fifth National Report on the CBD (MAIFS 2015).

Although the previous Mauritius NBSAP (2006 – 2015) did not incorporate the Aichi Targets, which were developed later in 2011, the strategic objectives and programmes of work of the previous NBSAP were fully in line with the 2020 Aichi Targets 5, 6, 7, 8, 9, 10, 11, 12, and 13, and to some extent with Targets 14, 18 and 19 as well (MAIFS 2015).

Key successes were achieved over the last five years, as identified by the Fifth National Report on the CBD. Positive trends have been registered for 4 bird species *(Psittacula eques, Foudia rubra, Foudia flavicans, Acrocephalus rodricanus*) and 1 bat species (*Pteropus niger*) (contribution to Aichi Target 12). A significant increase in octopus' populations as well as mean octopus size and weight have been achieved in Rodrigues since 2012 (contribution to Aichi Target 6). This was due to the implementation of regulations on seasonal fishing closure. This was accompanied by a sensitisation campaign across the island and the development of alternative activities during the closure period so as to ensure proper understanding by all stakeholders of the motivations that led to this management decision (IOC, 2012; Shoals Rodrigues, RRA).

However, the Fifth National Report on the CBD also identified significant challenges for an effective implementation of the NBSAP:

- Institutional NBSAP coordination process for implementation, monitoring and evaluation has not fully been institutionalised and sustained. Under the responsibility of the MESDDBM (now MSSNSESD Ministry of Social Security, National Solidarity and Environment and Sustainable Development) until 2012, CBD and NBSAP implementation has been transferred to the NPCS, under the overall responsibility of MAIFS.
- There is significant fragmentation in the responsibilities among various ministries and institutions in the implementation of the NBSAP. For example, there is still much confusion about the responsibilities over the management of freshwater biodiversity.
- There is inadequate information (no centralised database) and knowledge sharing amongst institutions and stakeholders.

- Serious baseline knowledge gaps exist on identifying, inventorying and characterising local terrestrial and marine flora and fauna species, including microorganisms, benthic fauna and entomology among various topics.
- There are insufficient staff numbers, a shortage of qualified and experienced technical and administrative / management staff.
- Capacities building gaps have been identified in technical and scientific areas and in core activities. These have been listed in the National Self-Capacity Assessment (Ministry of Finance and Economic Development and Ministry of Environment, Sustainable Development and National Development Unit, 2005), which is still up to date.
- Thematic issues have been raised as priorities for research and action, namely (i) inland watershed, rivers, estuaries and terrestrial coastal systems biodiversity, (ii) outer islands and the Exclusive Economic Zone (EEZ) geographical cover, and (iii) climate change impact on biodiversity.

The Fifth National Report on the CBD calls for the:

- Harmonisation of institutional mandates in the area of terrestrial biodiversity conservation.
- Setting up and implementation of a national NBSAP coordination structure.
- Improved communication and information sharing between scientific/technical and non-scientific/technical stakeholders and persons.
- Sustainability of mechanisms developed (NBSAP coordination committee) and effective funding mechanisms (dedicated long-term fund).

These gaps and challenges have been confirmed by the NBSAP 2017 – 2025 preparatory study *Advances in cross-sectoral mainstreaming of biodiversity in Mauritius* (MAIFS 2017d), which discusses, in depth, biodiversity conservation and mainstreaming efforts up to September 2016, highlighting key challenges, gaps and opportunities. Despite some positive efforts, especially in indigenous bird, reptile and plant species conservation and recovery, weak progress was found for most Aichi Targets. A summary of the progress towards reaching the Aichi Targets is presented in Tables 1.10 to 10.14.

According to stakeholders and information gathered and analysis, the lack of progress in biodiversity mainstreaming is linked to the lack of effective coordination and monitoring of all biodiversity related targets, activities, budget / expenditures and project outcomes. Significant knowledge, attitude and commitment gaps exist in numerous areas, including on the values of biodiversity and ecosystem services, existing harmful subsidies, ecosystem services supply, demand, trade-offs and associated risks, and the barriers / opportunities for biodiversity mainstreaming in the public and private sectors.

Table 1.10: Progress towards reaching Aichi Targets of Strategic Goal A in Mauritius (MAIFS 2017d) scales of score: 4- excellent, 3- good, 2- medium, 1- weak, 0- none

Strategic Goal	Aichi Target	Score	Short explanation
A - Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society	1- By 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably	1	General awareness of importance of some ecosystem services, very limited understanding of values (a couple of limited studies) => as a result, very limited understanding of steps that need to be undertaken
	2- By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.	1	Environmental Sensitive Areas have been identified but limited integration in land use planning, experimental ecosystem accounts for the country (no mainstreaming yet)
	3- By 2020, at the latest, incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed in order to minimise or avoid negative impacts, and positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the Convention and other relevant international obligations, taking into account national socio economic conditions.	0	No study / assessment undertaken to date
	4- By 2020, at the latest, Governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits.	1	Several activities undertaken but diverse sectors to produce or consume in a more environmentally friendly manner, but concept of safe ecological limits not appropriate to Mauritius. The extent of ecosystem degradation requires thinking in terms of investing in ecological restoration and targeting no-net-loss and (ideally) net gains in biodiversity values

Community members in Rodrigues learning about native plant propagation (Photo: John Mauremootoo)

View of the west coast of Mauritius from Chamarel (Photo: John Mauremootoo)

Table 1.11: Progress towards reaching Aichi Targets of Strategic Goal B in Mauritius (MAIFS 2017d) scales of score :4- excellent, 3- good, 2- medium, 1- weak, 0- none

Strategic Goal	Aichi Target	Score	Short explanation
B - Reduce the direct pressures on biodiversity and promote sustainable use	5- By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced	2	A significant proportion of remaining natural or semi natural habitats are legally protected, but the protected area network is still far from complete. Focus on restoration of ecological integrity, with several successful projects over relatively small surface areas. Many challenges remain with alien invasive species.
	6- By 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits.	1	Coastal and marine ecosystems are under ongoing pressures, with many fish stocks depleted and significant proportions of all habitats degraded (rivers, estuaries, coral reefs, mangroves), restoration projects are planned
	7- By 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.	1	Positive steps by Forestry Service to plant native species (but exotic species are still the main ones used), very degraded ecological infrastructure in most farmlands and ongoing pollution (chemicals)
	8- By 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity.	1	No clear targets, no adequate monitoring / statistics (only focusing on chemical properties of water) and limited controls
	9- By 2020, invasive alien species and pathways are identified and prioritised, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.	1	National Invasive Alien Species Strategy and Action Plan has been developed but never really implemented
	10- By 2015, the multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimised, so as to maintain their integrity and functioning.	1	Coral reefs under increasing pressures, no sign of recovery

Table 1.12: Progress towards reaching Aichi Targets of Strategic Goal C in Mauritius (MAIFS 2017d) scales of score :4- excellent, 3- good, 2- medium, 1- weak, 0- none

Strategic Goal	Aichi Target	Score	Short explanation
C - To improve the status of biodiversity by safe-guarding ecosystems, species and genetic diversity	11- By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.	2	Some progress achieved in expanding protected areas. Key challenge is their effective management, especially of IAS, for ecological integrity
	12- By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.	2	Good progress for birds and reptiles. Some progress for plants but very little done for invertebrates and habitats.
	13- By 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimising genetic erosion and safeguarding their genetic diversity.	2	National strategy for the conservation and sustainable use of crop wild relatives adopted. It needs to be implemented. More work needed for local varieties and breeds.

Table 1.13: Progress towards reaching Aichi Targets of Strategic Goal D in Mauritius (MAIFS 2017d) scales of score :4- excellent, 3- good, 2- medium, 1- weak, 0- none

Strategic Goal	Aichi Target	Score	Short explanation
D - Enhance the benefits to all from biodiversity and ecosystem services	14- By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.	1	Very limited spatially-explicit assessment of the supply and delivery of ecosystem services to different stakeholder groups available in Mauritius and Rodrigues. Very limited restoration work to date.
	15- By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.	1	Very limited restoration progress to date. Ecosystem-based study undertaken.
	16- By 2015, the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilisation is in force and operational, consistent with national legislation.	1	Nagoya Protocol ratified but specific legislation pending. No projects yet.

Table 1-14: Progress towards reaching Aichi Targets of Strategic Goal E in Mauritius (MAIFS 2017d) scales of score :4- excellent, 3- good, 2- medium, 1- weak, 0- none

Strategic Goal	Aichi Target	Score	Short explanation
E - Enhance implementation through participatory planning, knowledge management and capacity building	17- By 2015 each Party has developed, adopted as a policy instrument, and has commenced implementing an effective, participatory and updated national biodiversity strategy and action plan	1	New NBSAP 2017 - 2025 about to be adopted, with broad stakeholder consultation, but no effective progress monitoring and lack of leadership to date
	18- By 2020, the traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels.	0	No indigenous people in Mauritius. All descendants of immigrants.
	19- By 2020, knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.	1	Lack of knowledge and no effective sharing mechanism to date.
	20- By 2020, at the latest, the mobilisation of financial resources for effectively implementing the Strategic Plan for Biodiversity 2011-2020 from all sources, and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilisation, should increase substantially from the current levels. This target will be subject to changes contingent to resource needs assessments to be developed and reported by Parties.	1	No stakeholder-based budget needs assessment, access to information problematic.

Echo parakeets in native forest (Photo: Gaby Salazar)

1.4.2 Developing the NBSAP 2017 – 2025

The Ministry of Agro-Industry and Food Security (MAIFS), with the financial support of the GEF and UNDP, undertook to update Mauritius' NBSAP to address the country's obligations under Article 6a of the CBD. A National Project Steering Committee, then chaired by the Deputy Permanent Secretary of MAIFS, and composed of key stakeholders, was set to guide the process.

Initial stakeholder consultations for the NBSAP 2017 – 2025 stocktaking exercise started in 2015. This work culminated with the production of the 5th National Report on the CBD in late 2015. Work on the NBSAP 2017 – 2025 then started in early 2016 and was finalised in early 2017. In Mauritius, three separate consultations, in May, October and November 2016, were undertaken with the three NBSAP working groups: The Terrestrial Biodiversity Working Group, the Agro-biodiversity Working Group and the Marine, Coastal & Freshwater Biodiversity Working Group. In Rodrigues, a single two-day consultation process with key Rodrigues stakeholders was undertaken in November 2016.

The 2016 consultation processes covered:

- A review of all twenty Aichi targets;
- A review of a 2015 NBSAP stocktaking exercise;
- A review of selected proposed NBSAP targets and associated indicators;
- Discussions on which institutions should lead specific work areas and what are the capacity, technological and financial needs to implement Mauritius-specific Aichi targets;
- Discussions on adapting the Aichi Targets to the RoM context, including key performance indicators, Lead Agency and Partners, deadlines and provisional additional budget requirements;
- The development of national targets and actions plans for Mauritius and Rodrigues

2 NATIONAL BIODIVERSITY STRATEGY: VISION, MISSION STATEMENT, PRINCIPLES, STRATEGIC OBJECTIVES AND TARGETS

2.1 Vision

"People in the Republic of Mauritius enjoy a healthy environment and an enhanced quality of life, through the effective conservation, sustainable use and restoration of biodiversity in line with national and international commitments, while respecting local values."

2.2 Mission Statement

"Mauritius will continue to work towards achieving a significant reduction in the rate of biodiversity loss by 2025, achieve ecosystem resilience capacity to climate change and start to build an ecosystem-based economy which invests in the restoration of biodiversity values."

2.3 Working Principles for the NBSAP 2017 – 2025

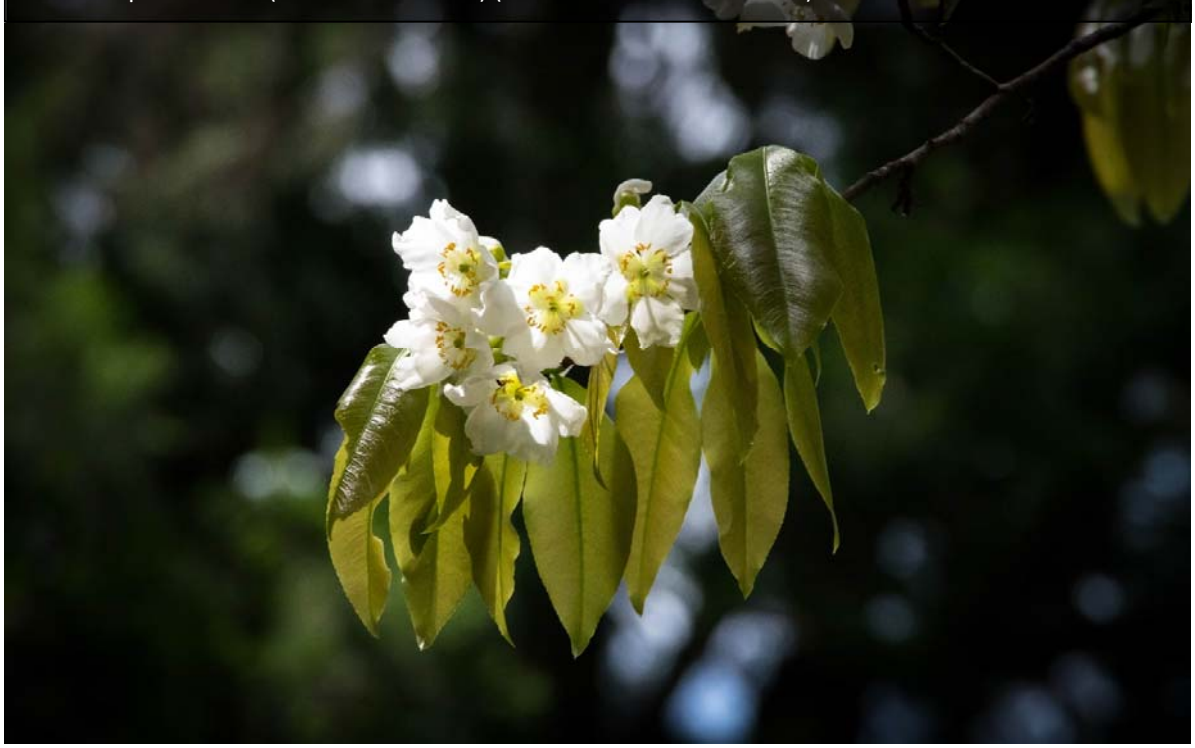
The adopted Working Principles are as follows:

- Integration of the ecological, social and economic values of biodiversity into decision-making;
- Effective in-situ and ex-situ biodiversity conservation and / or restoration;
- Minimising the direct and indirect pressures on biodiversity and ecosystem services;
- Biodiversity mainstreaming in the public and private sectors;
- Effective information sharing, NBSAP monitoring and delivery;
- The ecosystem approach.

2.4 Strategic objectives and national targets for the RoM

As the Secretariat of the Convention on Biological Diversity (2016) calls for more ambitious NBSAP and meaningful progress towards achieving the Aichi Targets and the Strategic Plan for Biodiversity 2011 – 2020, the RoM has called for all stakeholders to set up ambitious but realistic national targets, considering local challenges, especially in terms of financial and human resources constraints. The RoM has retained the five CBD strategic goals and has adapted the corresponding Aichi Targets as outlined below.

Bois bouquet banané (*Ochna mauritiana*) (Photo: John Mauremootoo)



Strategic Goal A "Addressing the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society" shall be achieved through the following national targets:	
	National Target 1: By 2025, the diverse set of key biodiversity values of priority areas / taxa and steps to conserve and use them sustainably have been assessed and are being monitored in an integrated manner for awareness raising and fully-informed decision making (contribution to Aichi Target 1);
	National Target 2: By 2025, practical pathways are identified and various tools help integrate the diverse set of biodiversity values in public and private policy, decision-making, planning, production, accounting and reporting processes (contribution to Aichi Target 2);
	National Target 3: By 2025, the incentives, including subsidies, harmful to biodiversity across all sectors have been assessed and practical pathways for incentives to reward pro-biodiversity practices and outcomes by all stakeholders, including the private sector, are being implemented (contribution to Aichi Target 3);
	National Target 4: By 2025, sectoral biodiversity mainstreaming plans in key economic sectors, in partnership with the target stakeholders, start to be implemented, based (a) on recreating resilient ecosystems and their capacity to supply a wide variety of ecosystem services and (b) on adopting no net loss and (ideally) net gains of biodiversity values as guiding principles in all new development projects (contribution to Aichi Target 4).

Strategic Goal B "Reducing the direct pressures on biodiversity and promote sustainable use" shall be achieved through the following national targets:	
	National Target 5: By 2025, the loss of natural habitats is halted and ecological integrity of significant areas of degraded and fragmented habitats is restored, focusing on an expanded PAN and ESA (contribution to Aichi Target 5);
	National Target 6: By 2025, the sustainable management, harvesting and / or recovery of priority marine and freshwater resources is achieved (contribution to Aichi Target 6);
	National Target 7: By 2025, a pro-active policy framework, with incentives for pro-biodiversity practices and disincentives for harmful practices, to offset the opportunity costs (e.g. training, certification costs, loss of productivity) for shifting towards biodiversity friendly production systems, is developed and implemented (contribution to Aichi Target 7);
	National Target 8: By 2025, a pro-biodiversity pollution minimisation strategy, focusing on the restoration of freshwater systems (from mountains / catchment to sea) and on reducing water use and emissions, including nutriments, is set up and implemented across sectors (contribution to Aichi Target 8);
	National Target 9: By 2025, the NIASSAP is revised and fully implemented through adequate financial and human resources commensurate to the existing challenges and the impacts caused by IAS are minimised (contribution to Aichi Target 9);
	National Target 10: By 2025, at least 20% of degraded coral reef areas are sustainably managed and / or rehabilitated (contribution to Aichi Target 10).

Strategic Goal C "to improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity" shall be achieved through the following national targets:	
	National Target 11: By 2025, at least 16 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes (contribution to Aichi Target 11);
	National Target 12: By 2020, the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained (contribution to Aichi Target 12);
	National Target 13: By 2020, the genetic diversity of cultivated plants, farmed and domesticated animals and of wild crop relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimising genetic erosion and safeguarding their genetic diversity (contribution to Aichi Target 13).

Strategic Goal D "to enhance the benefits to all from biodiversity and ecosystem services" shall be achieved through the following national targets:	
	National Target 14: By 2025, ecosystems that provide essential services, including services related to water, and contribute to health and well-being, are restored and safeguarded, taking into account the needs of women and local com munities, and the poor and vulnerable (contribution to Aichi Target 14);
	National Target 15: By 2025, steps for enhancing ecosystem resilience and the contribution of biodiversity to carbon stocks are undertaken, focusing on conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation (contribution to Aichi Target 15);
	National Target 16: By 2020, a legal framework for implementing the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilisation is adopted, and by 2025 best practice case studies are showcased (contribution to Aichi Target 16).

Strategic Goal E "to enhance implementation through participatory planning, knowledge management and capacity building" shall be achieved through the following national targets:	
	National Target 17: By 2020, the NBSAP is adopted and mainstreamed in all relevant policies and legislations and is fully funded, monitored and implemented to achieve the Aichi Targets (contribution to Aichi Target 17);
	National Target 19: By 2020, knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied (contribution to Aichi Target 19);
	National Target 20: By 2017, a financial resources mobilisation strategy and action plan is adopted, targeting all potential public and private sources, leading to substantial increases in biodiversity funding available to implement the NBSAP (contribution to Aichi Target 20).

3 NATIONAL ACTION PLAN

Following stakeholder consultations, it was decided to develop separate Biodiversity Action Plans for (a) the Island of Mauritius and its associated islets and (b) Rodrigues Island and its associated islets. Each Action Plan contains:

- Programmes,
- Activities, with Key Performance Indicators where available,
- Lead Agency and Partners,
- Timeframes (2020 and 2025 deadlines specified), and
- Additional provisional budget needs

Each Biodiversity Action Plan is presented in tables per national target. Addressing knowledge gaps in biodiversity mainstreaming into national policies, strategies and plans and into sectoral policies, strategies and plans, across government, the private sector and civil society are made a priority in each Action Plan.

Awareness-raising poster produced under the UNDP/GEF PAN Project

3.1 Mauritius Biodiversity Action Plan

The following Biodiversity Action Plan applies to Mauritius, its islets and the associated coastal and marine zones (EEZ), apart from Rodrigues and its islets. It is important to note that action plans under a specific target apply to other action plans as well. For instance, national target 9 (IAS management) will contribute to targets 5 (natural habitat degradation), 11 (protected area network expansion and management), 12 (threatened species management).

National Target 1: By 2025, the diverse set of key biodiversity values of priority areas / taxa and steps to conserve and use them sustainably have been assessed and are being monitored in an integrated manner for awareness raising and fully informed decision making						
Programme	Activities, with Key Performance Indicators (KPI) where available	Lead Agency and Partners	Priority	Deadline		Additional provisional budget
				2020	2025	
M-01-01: Comprehensive Coastal & Marine Biodiversity Assessment, Mapping, Valuation, Monitoring, Capacity Building & Education Programme	M-01-01-01: Pilot integrated ecological, cultural and economic valuation studies undertaken at several ESA, including but not limited to Blue Bay Marine Park and Pointe D'Esny, and for marine mammals	MOEMRFS as lead agency, with support from MSSNSESD, MOI, UoM, Entomology Division, MSIRI, NGOs (Reef Conservation, Eco-Sud, MMCS, MWF)	High	X		US$ 400,000
	M-01-01-02: Gaps identified (e.g. lack of mapping of marine ecosystem extent and condition), resource needs assessed, funding secured for the whole project		High	X		US$ 50,000
	M-01-01-03: A comprehensive capacity building and educational programme is developed and implemented for the benefits of public and private sector, including fisheries and tourism sectors, building on existing educational / awareness raising work and the latest research and good practices. Subsidiary KPI: Number of Master and PhD students and valuation-related jobs, number & percentage of fishermen and sea-based tourism operators trained & educated on sustainable fisheries & conservation per year, number & percentage of school children sensitised about coastal and marine biodiversity per year		High	X	2025	US$2.5 million
	M-01-01-04: The diverse values (cultural, ecological, economic) of Coastal and Marine Biodiversity (throughout the EEZ) are assessed / mapped in ecological, cultural and monetary terms and strategies / action plans with quantified targets are identified and implemented to restore degraded or lost values NB: Focus on mapping and quantifying all marine ecosystems and resources as baseline information for effective valuation Subsidiary KPI: Proportion of sector, ESA, ecosystem, EEZ and taxa covered		High		X	US$1 million

National Target 2: By 2025, practical pathways are identified and various tools help integrate the diverse set of biodiversity values in public and private policy and decision-making, planning, production, accounting and reporting processes						
Programme	Activities, with Key Performance Indicators (KPI) where available	Lead Agency and Partners	Priority	Deadline		Additional provisional budget
				2020	2025	
M-02-01: Biodiversity values mainstreaming in the public sector	M-02-01-01: Assessment of potential pathways, barriers and opportunities for biodiversity values mainstreaming in public policy and decision-making, planning, production, accounting and reporting processes completed NB: Assessment covers agro-biodiversity, terrestrial, freshwater, coastal and marine ecosystems	MAIFS & MOEMRFS to identify key partners	High	X		US$ 130,000
	M-02-01-02: Mainstreaming is starting in priority processes, including land use and marine spatial planning, national statistics / accounting and reporting Subsidiary KPI: number of biodiversity-related jobs, biodiversity-related criteria in public and private procurement, expenses per biodiversity value type and sector		High		X	Embedded in future activities
	M-02-01-03: Terrestrial, coastal and marine ESA are updated, accurately mapped and legally protected	MSSNSESD, MOEMRFS	High	X		Embedded in future activities
Biodiversity values mainstreaming in the private sector	M-02-02-01: Assessment of potential pathways, barriers and opportunities for biodiversity values mainstreaming in private policy and decision-making, planning, production, accounting and reporting processes. NB: Assessment covers agro-biodiversity, terrestrial, freshwater, coastal and marine ecosystems.	MAIFS, as lead agency, with support from Stock Exchange of Mauritius, private sector		High	X	US$ 150,000
	M-02-02-02: Mainstreaming is starting in priority industries (e.g. tourism, financial sector, agriculture, landscaping, construction, infrastructure development, fisheries, ocean mining), in terms of corporate policies, strategies and practices Subsidiary KPI: Number of companies engaged in biodiversity mainstreaming, types of mainstreaming activities initiated, company disclosures (impacts and dependencies), number of biodiversity-related jobs created in the private sector.		Medium		X	Embedded in future activities (stakeholders to be determined)

National Target 3: By 2025, the incentives, including subsidies, harmful to biodiversity across all sectors have been assessed and practical pathways for incentives to reward pro-biodiversity practices and outcomes by all stakeholders, including the private sector, are being implemented						
Programme	Activities, with Key Performance Indicators (KPI) where available	Lead Agency and Partners	Priority	Deadline		Additional provisional budget
				2020	2025	
M-03-01: Phasing out subsidies harmful to biodiversity	M-03-01-01: Study on harmful subsidies, pathways for their elimination, phasing out or reform and potential positive incentives (e.g. including how to sustain existing schemes, such as CSR, and make them focus on projects contributing to the Aichi Targets) for the conservation and sustainable use of biodiversity completed. NB: Assessment covers agro-biodiversity, terrestrial, freshwater, coastal and marine ecosystems, as well as key sectors such as tourism, property development, financial services, fisheries, agriculture, infrastructure, ocean mining, government ministries and local authorities.	MFED leading, with support from all relevant ministries and stakeholders	High	X		US$ 200,000
	M-03-01-02: Incentives favouring the use, cultivation or dissemination of species that are known to be invasive in Mauritius or suspected of becoming invasive (based on risk assessment) are clearly identified and documented, such incentives are in the process of being phased out, and, as far as possible, are replaced by incentives for the prevention and control of such species. <u>Subsidiary KPI:</u> Report on incentives with specific recommendations.		High	X		Embedded in future activities (stakeholders to be determined)
	M-03-01-03: Key harmful subsides are progressively phased out		Medium		X	
M-03-02: Setting up sustainable incentives for biodiversity conservation and restoration	M-03-02-01: New sustainable funding sources (e.g. non-sinking funds) and fiscal incentives secured (e.g. from phased out harmful subsidies) to reward pro-biodiversity actions, outcomes and / or stewardship / restoration. NB: Covers terrestrial, freshwater, coastal and marine biodiversity.	MFED leading, with support from all relevant ministries and stakeholders	Medium		X	Embedded in future activities (stakeholders to be determined)
	M-03-02-02: Projects supporting Aichi Targets are given priority status by the GoM in CSR grants by companies.		High	2017	Continuous	
	M-03-02-03: Feasibility study for farmers' compensation scheme (opportunity costs, including transition period) to promote CWR and local breeds / cultivars completed.		Medium		X	US$ 100,000

National Target 4: By 2025, sectoral biodiversity mainstreaming plans in partnership with the target stakeholders in key economic sectors as guiding principles in existing and new development projects, and are based (a) on recreating resilient ecosystems and their capacity to supply a wide variety of ecosystem services and (b) on adopting no net loss and (ideally) net gains of biodiversity values						
Programme	Activities, with Key Performance Indicators (KPI) where available	Implementing	Priority	Deadline		Additional provisional
				2020	2025	
M-04-01: Ecosystem services and biodiversity no-net-loss / net gain mainstreaming action plans in the public and private sectors	M-04-01-01: Study on sectoral biodiversity mainstreaming in key target sectors (e.g. tourism, property development, financial services, fisheries, ocean mining, agriculture, infrastructure, local authority services, national government ministries) completed, with focus on barriers and opportunities for ecosystem services stewardship and adoption of biodiversity no-net-loss / net gain policies.	Target private sector representatives, MSSNSESD, SEM, MAIFS	Medium	X		US$ 250,000
	M-04-01-02: Sectorial action plans adopted and are being implemented, focusing on ecosystem restoration / rehabilitation and no-net-loss / net gains of biodiversity values as underlying principles for all new projects.	Target private sector representatives, SEM, MAIFS, MSSNSESD, MOEMRFS	Medium		X	Embedded in future activities (stakeholders to be determined)

National Target 5: By 2025, the loss of natural habitats is halted and ecological integrity of significant areas of degraded and fragmented habitats is restored, focusing on an expanded PAN and ESA						
Programme	Activities, with Key Performance Indicators (KPI) where available	Lead Agency and Partners	Priority	Deadline		Additional provisional budget
				2020	2025	
M-05-01: Biodiversity values protection, rehabilitation and / or restoration programme	M-05-01-01: Legal framework for ESA is in place and enforced (i.e. no further loss of ecosystems such as coral reefs, forests and wetlands).	AGO as advisory agency, with support from MSSNSESD, MOEMRFS, NPCS, FS, MFED	High	X		-
	M-05-01-02: At least 1,500 ha of PAN (public and private land) effectively managed for ecological integrity and new targets set for 2025.	NPCS and FS as lead agencies	High	X		US$3 million

National Target 6: By 2025, the sustainable management, harvesting and / or recovery of priority marine and freshwater resources is achieved						
Programme	Activities, with Key Performance Indicators (KPI) where available	Lead Agency and Partners	Priority	Deadline		Additional provisional budget
				2020	2025	
M-06-01: Mainstreaming biodiversity into the management of the coastal and marine zones	M-06-01-01: Threats to biodiversity and ecosystem function are addressed by ensuring that 27,000 ha of marine and coastal Environmentally Sensitive Areas (ESAs) are an integral part of planning and implementation mechanisms relating to coastal development and the tourism sector.	MOEMRFS as lead agency, with support from PMO, MOI, OIDC, NGOs, MWF	High	X		US$ 4 million (excluding co-funding)
	M-06-01-02: Threats to marine and coastal biodiversity are mitigated and fishery resources protected in at least 20,000 ha of seascapes, through the improved management of MPAs and the development of no-take zones.		High	X		
	M-06-01-03: Study to determine the fish stock and exploitation thresholds of coastal and marine resources, including the assessment of the sustainability of fisheries in EEZ.		High	X		US$ 300,000
	M-06-01-04: Monitoring system and effective measures identified and implemented to improve sustainability of fisheries in EZZ and St Brandon.		Medium		X	US$ 200,000 / year
	M-06-01-05: Marine Spatial Plan (MSP) is fully supported and progress achieved for the Republic of Mauritius, including Rodrigues.	MDR - DCSMZAE as lead agency.	High		X	US$ 750,000

National Target 7: By 2025, a pro-active policy framework, with incentives for pro-biodiversity practices and disincentives for harmful practices, is developed and implemented.						
Programme	Activities, with Key Performance Indicators (KPI) where available	Lead Agency and Partners	Priority	Deadline		Additional provisional budget
				2020	2025	
M-07-01: Sustainable Agriculture Programme	M-07-01-01: 400 ha of restored river areas (ecological integrity) with indigenous species.	MAIFS and FS as lead agency with the support of private sector, NGOs and FAREI	High		X	US$ 1.2 million
	M-07-01-02: Surface area and / or population size cultivated with CWR, local cultivars and breeds assessed and expansion target per type established.		High	X		US$ 225,000
	M-07-01-03: 25 ha of food crops under the biofarming scheme.		High	X		Existing scheme
	M-07-01-04: 2% of food crop growers are certified under the MauriGAP standard, production volumes are assessed and expansion targets are defined and adopted.		High	X		Embedded in future activities (stakeholders to be determined)
	M-07-01-05: Development of practical guidelines and action plan for domestic and wild pollinators and soil biodiversity conservation and restoration in agriculture (food, sugar cane, livestock).		High	X		US$ 50,000
M-07-02: Sustainable Forestry Programme	M-07-02-01: Development of practical guidelines and action plan for biodiversity conservation and restoration in forestry.	Forestry Service, PAN stakeholders (e.g. hunting leases)	High	X		US$ 50,000
	M-07-02-02: 2,000 hectares of forest under active management and restoration.		High		X	US$ 6 million
M-07-03: Sustainable Aquaculture Programme	M-07-03-01: Coastal and marine ESA areas protected from aquaculture projects (forbidden).	MOEMRFS, MOI	High	X		-
	M-07-03-02: Monitoring system in place to monitor water quality and impacts on wild populations.		High	X		US$ 75,000 / year

National Target 8: By 2025, a pro-biodiversity pollution minimisation strategy, focusing on the restoration of freshwater systems (from mountains / catchment to sea) and on reducing water use and emissions, including nutriments, is set up and implemented across sectors						
Programme	Activities, with Key Performance Indicators (KPI) where available	Lead Agency and Partners	Priority	Deadline		Additional provisional budget
				2020	2025	
M-08-01: Comprehensive Freshwater Pollution Minimisation Programme	M-08-01-01: Enforcement of existing regulations for effluent discharges. Subsidiary KPI: number and extent of violations, actions taken and complaints.	CWA, WMA, MAIFS, FAREI, MSSNSESD, AGO	High	X		Ongoing
	M-08-01-02: Study on human (capacity, skills, knowledge), technological and financial resource needs completed.		High	X		US$ 50,000
	M-08-01-03: Monitoring system (biodiversity-related indicators) on water quality for human, industrial, agricultural and ecosystem purposes in place for point and non-point source pollution per catchment established.		Medium		X	US$ 1 million
	M-08-01-04: Initiate action to amend the current Chemical Fertiliser Act to incorporate all fertilizers, including but not limited to organic fertilisers and soil conditioners.		High	X		-
	M-08-01-05: Pesticide use regulation fully enacted and implemented, listing continuously updated as per international good practice / latest research.		High	X		-
	M-08-01-06: Guidelines for the management and disposal of hydroponic effluents developed.		High	X		US$ 150,000
	M-08-01-07: Pollution reduction targets established for non-point source pollution in each catchment (stricter legislation).		Medium		X	US$ 300,000
M-08-02: Comprehensive Marine Debris Management Programme	M-08-02-01: Comprehensive study completed to identify the main pathways for marine debris pollution for offshore islets and outer islands.	NPCS, FS MWF, OIDC, Raphael Fishing	High	X		US$ 300,000
	M-08-02-02: Development of a marine debris strategy and action plan for offshore islets and outer islands (Tons of debris collected per island / islet per year).		Medium		X	US$ 50,000 / year

National Target 9: By 2025, the NIASSAP is revised and fully implemented through adequate financial and human resources commensurate to the existing challenges and the impacts caused by IAS are minimised					
Programme: Implementation of NIASSAP (M-09-01) Activities, with Key Performance Indicators (KPI) where available	Lead Agency & Partners	Priority ranking	Deadline		Additional provisional budget
			2020	2025	
M-09-01-01: NIASSAP is reviewed and revised, with progress assessed, gaps identified (inc. marine IAS) and activities fully costed with precise timeline for implementation for both terrestrial and marine IAS.	NPCS, MAIFS, MOEMRF, IUCN, FS, WWF, private sector	High	X		US$ 40,000
M-09-01-02: Up-to-date lists of terrestrial and marine invasive species of all taxa present in Mauritius completed and publicly available, and a system for their regular updating is in place and is being used. Subsidiary KPI: species lists online.		High	2025		US$ 30,000
M-09-01-03: Pathways of introduction of new species into Mauritius and between the islands of RoM are identified, their relative importance is quantified, and they are prioritised for management action to reduce the rate of arrival of new species. Subsidiary KPI: Published document identifying pathway importance, with specific management recommendations and action plan adopted and implemented for the improved management of the major pathways identified as priorities due to their high potential for the introduction of invasive species to the RoM or between its islands.		High	2025		
M-09-01-04: A comprehensive risk assessment system is in place and being used in Mauritius, to (1) assess the risks that new species proposed for importation to the RoM or moved between its islands may become invasive (border control), and (2) assess the risks associated with species already present in the RoM but which may not yet have become invasive there (management prioritisation). Subsidiary indicators: (1) Risk assessment system in use for border control (proposed imports and translocations between islands for all taxa); (2) risk assessment system for introduced plants (at least) that are already present in RoM, developed and in use.		High	2025		US$ 200,000
M-09-01-05: Species identified by formal risk assessment as having high invasiveness potential in the RoM are refused permission for importation or for translocation between its islands. Subsidiary indicators: Reports on outcomes of applications for permission to import/transport.		High	2025		-
M-09-01-06: Procedures for controlling the unregulated (illegal) importation of species to the RoM (including for aquaculture) or between its islands are improved (effective quarantine system with sanctions for deliberate infractions). Subsidiary indicators: Improved traveller/importer awareness; improved port-of-entry inspection procedures; number of fines / sanctions.		High	2025		US$ 2 million
M-09-01-07: Species present in Mauritius, with high invasive potential but still present only in limited areas, are prioritised for management and where feasible eradication, by means of a formal risk assessment process, including, as far as possible, their declaration as “harmful”, “prohibited”, or similar. Subsidiary indicators: List of potential high-priority management targets; number of species managed; management plans for priority species developed and implemented; number of hectares cleared per target species.		High	2025		US$ 4 million

National Target 10: By 2025, at least 20% of degraded coral reef areas are sustainably managed and / or rehabilitated						
Programme	Activities, with Key Performance Indicators (KPI) where available	Lead Agency and Partners	Priority	Deadline		Additional provisional budget
				2020	20 25	
Coral reef restoration programme	At least 20% of degraded coral reefs in Mauritius are sustainably managed and / or rehabilitated.	MOEMRFS, MOI, Reef Conservation, Eco-Sud, MMCS, UOM	High	X		Embedded in other activities

National Target 11: By 2025, at least 16 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes						
Programme	Activities, with Key Performance Indicators (KPI) where available	Lead Agency and Partners	Priority	Deadline		Additional provisional budget
				2020	2025	
M-11-01: Terrestrial Network Management and Expansion Protected Area	M-11-01-01: 20,000 ha of new formal PA declared, including at least 2 private reserves.	NPCS, FS, private landowners and leaseholders, MWF	High	2025		
	M-11-01-02: Management plans for new formal protected areas developed and implemented.		High	2025		-
	M-11-01-03: Develop a Red List of ecosystems for Mauritius (2020) and update it (2025).		High	X	X	US$ 25,000
	M-11-01-04: Develop guidelines and working criteria for ecosystem restoration/creation for the various ecosystem types, including but not limited to Pandanus marshes, montane forest, heath forests, palm rich forests, *Helichrysum* forests, etc.		Medium	X		US$ 150,000
	M-11-01-05: Develop guidelines and working criteria for what constitutes effective conservation management areas.		High	X		US$ 10,000
	M-11-01-06: Independent management effectiveness scores for all PA carried out every 5 years, including over planning, financial sustainability and ecological integrity and resource use aspects.			2025		US$ 5,000 to 15,000 per assessment
	M-11-01-07: 1,000 ha of conservation management areas in total.			X		US$ 1.2 million
	M-11-01-08: Restoration and creation targets defined for highly threatened ecosystem types.		High	X		US$ 25,000
M-11-02: Marine Protected Area Expansion Strategy	Marine Protected Area Expansion Strategy and Action Plan completed, including the EEZ and no-take zone targets for effective conservation. <u>Subsidiary KPI:</u> Targets for new MPA creation, including for no-take areas.	MOEMRFS, MOI, Reef Conservation, Eco-Sud, MMCS	High	X		US$ 1 million
	Marine Protected Area Strategy is progressively implemented. <u>Subsidiary KPI:</u> Proportion of lagoon and open-sea marine zoned as no-take area.		High		X	

National Target 12: By 2025, a pro-active policy framework, with incentives for pro-biodiversity practices and disincentives for harmful practices, is developed and implemented.						
Programme	Activities, with Key Performance Indicators (KPI) where available	Lead Agency and Partners	Priority	Deadline		Additional provisional budget
				2020	2025	
M-12-01: Terrestrial Threatened Species Conservation Programme	M-12-01-01: Complete and / or update the red-listing of Mauritius endemic and indigenous fauna (inc. reptiles and land mammals) and flora (including CWR) species.	NPCS, MWF, FS, Vallée de Ferney	High	X		-
	M-12-01-02: Start the Red-listing process for other taxonomic groups (invertebrates, gastropods, lichens, bryophytes, pteridophytes, coastal and marine species, including corals, fish, molluscs, mammals).		Medium		X	US$ 100,000
	M-12-01-03: No species / taxa extinction.		High	2025		-
	M-12-01-04: Down-listing of 2 Red-Listed animal species and new target defined.		High	X		-
	M-12-01-05: Updated or new recovery plans in place for threatened bird, reptile, bat, plant and fern species.		Medium	X		US$ 250,000
M-12-02: Marine Threatened Species Conservation Programme	M-12-02-01: Complete red-listing of corals, fish, mammals, marine turtles, molluscs, holothurians by 2020, regularly update afterwards.	MOEMRFS, MOI, Reef Conservation, Eco-Sud, MMCS	High	X	Continuous	US$ 100,000
	M-12-02-02: New recovery plans in place for priority threatened marine species.		Medium		X	US$ 250,000

National Target 13: By 2020, the genetic diversity of cultivated plants, farmed and domesticated animals and of wild crop relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimising genetic erosion and safeguarding their genetic diversity.						
Programme	Activities, with Key Performance Indicators (KPI) where available	Lead Agency and Partners	Priority	Deadline		Additional provisional budget
				2020	2025	
M-13-01: Genetic diversity conservation	M-13-01-01: All activities of CWR NSAP implemented.	UoM, MAIFS, FAREI	High	2025		US$ 1.5 million
	M-13-01-02: Develop a national red-list and recovery and / or expansion plans for priority local breeds and cultivars.		High	X		US$ 25,000
	M-13-01-03: At least 3-4 taxa (local breeds, races and CWR) are characterised per year.		High	2025		-
	M-13-01-04: 10 accessions in National Seed Gene bank are characterised per year.		High	2025		-
	M-13-01-05: Livestock breed conservation scheme has been established and is sustainably funded.		High	2018, 2025		-
	M-13-01-06: At least two strategic crops are bred and promoted (e.g. onions, beans).		High	2018, 2025		US$ 50,000
M-13-02: Marine genetic diversity assessment programme	M-13-02-01: Study on genetic diversity of priority commercial species (fish, sea cucumbers, molluscs).	MOEMRFS, MOI	High	X		US$ 200,000
	M-13-02-02: Assessment and monitoring measures of fish escapees in aquaculture and genetic contamination.	MOEMRFS, MOI	High	X		US$ 200,000

National Target 14: By 2025, ecosystems that provide essential services, including services related to water, and contribute to health and well-being, are restored and safeguarded, taking into account the needs of women and local communities, and the poor and vulnerable.						
Programme	Activities, with Key Performance Indicators (KPI) where available	Lead Agency and Partners	Priority	Deadline		Additional provisional budget
				2020	2025	
M-14-01: Comprehensive Terrestrial & Freshwater Biodiversity Assessment, Mapping, Valuation, Monitoring, Capacity Building & Education Programme	M-14-01-01: Study on key ecosystem services (supply, demand, risk) for key sectors completed, including tourism and agriculture, and including human (capacity, skills, knowledge) and financial resource needs.	MAIFS as lead agency, with support from NPCS, FS, WRU	Medium	X		US$ 200,000
	M-14-01-02: Development and implementation of national capacity building programme on ecosystem services management and restoration. Subsidiary KPI: Number of Master and PhD students and valuation-related jobs, number of people training, awareness survey results.		Medium	X		US$ 750,000
	M-14-01-03: Development of strategy and action plan for priority areas and / or ecosystem services.		Medium		X	US$ 200,000
M-14-02: Comprehensive Coastal & Marine Biodiversity Assessment, Mapping, Valuation, Monitoring, Capacity Building & Education Programme	M-14-02-01: Study on key ecosystem services (supply, demand, risk) for key sectors completed, including tourism, fisheries and aquaculture, and including human (capacity, skills, knowledge) and financial resource needs.	MOEMRFS as lead agency, with support from MOI, Reef Conservation, Eco-Sud, MMCS	Medium	X		US$ 300,000
	M-14-02-02: Development of national capacity building programme on ecosystem services management and rehabilitation. Subsidiary KPI: Number of Master and PhD students and valuation-related jobs, number of people training, awareness survey results.		Medium	X		US$ 750,000
	M-14-02-03: Development of action plan for priority areas and / or ecosystem services.		Medium		X	US$ 200,000

National Target 15: By 2025, at least 20% of degraded coral reef areas are sustainably managed and / or rehabilitated						
Programme	Activities, with Key Performance Indicators (KPI) where available	Lead Agency and Partners	Priority	Deadline		Additional provision budget
				2020	2025	
M-15-01: Carbon Stock Enhancement Programme	M-15-01-01: In-situ carbon stock assessment and monitoring starts for different PA (Tons CO_2 eq.), differentiating between different types of forests and wetlands (native vs exotic).	NPCS, FS, FAREI	Medium	X	Continuous	US$ 400,000
	M-15-01-02: In-situ carbon stock assessment and monitoring starts for different agricultural practices (e.g. vegetables, sugar came, fruits).	MAIFS, FAREI	Medium	2025		US$ 400,000
	M-15-01-03: Develop guidelines and capacity for natural and agricultural ecosystem restoration while minimising carbon loss.		Medium	X		US$ 50,000
	M-15-01-04: In-situ carbon stock assessment and monitoring starts for different marine ecosystems (coral reefs, seagrass meadows, mangroves).	MOEMRFS, MOI, FAREI	Medium	X	Continuous	To be determined

National Target 16: By 2020, a legal framework for implementing the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilisation is adopted, and by 2025 best practice case studies are showcased						
Programme	Activities, with Key Performance Indicators (KPI) where available	Lead Agency and Partners	Priority	Deadline		Additional provisional budget
				2020	2025	
M-16-01: Nagoya Protocol Implementation Programme	M-16-01-01: Develop and adopt a legal framework for implementation.	PMO, AGO, MAIFS, FAREI, UoM	High	X		US$ 75,000
	M-16-01-02: Pilot projects on legal framework for implementing the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilisation successfully implemented.		Medium		X	Project-dependent (private sector funding)

National Target 17: By 2020, the NBSAP is adopted and mainstreamed in all relevant policies and legislations and is fully funded, monitored and implemented to achieve the Aichi Targets						
Programme	Activities, with Key Performance Indicators (KPI) where available	Lead Agency and Partners	Priority	Deadline		Additional provisional budget
				2020	2025	
M-17-01: Mauritius Biodiversity Action Plan	M-17-01-01: NBSAP is fully endorsed by Cabinet	MAIFS as the focal point and coordinator, with support from all stakeholders	High	2025		-
	M-17-01-02: NBSAP implementation committee is sustainable (meeting every 3 months) and involves all key stakeholders.		High	2025		
	M-17-01-03: Each partner Ministry and stakeholder is committed to contributing to the national targets (budget, expenses, project KPI).		High	2025		
	M-17-01-04: The focal point designates a responsible officer for coordinating and monitoring the NBSAP, and each KPI is monitored on a quarterly basis.		High	Immediately		
	M-17-01-05: MoUs are drafted and signed by the focal point and lead stakeholders responsible for implementing each national target.		High	X		
	M-17-01-06: The NBSAP is effectively mainstreamed into policy and sectors (number of documented changes in policy and / or practice).		High	2025		
	M-17-01-07: NBSAP is reviewed in 5 years and amended through a fully participative consultation process.		High	X		US$ 125,000
	M-17-01-08: A new NBSAP is prepared through a fully participative consultation process.		Medium		X	US$ 250,000

National Target 19: By 2020, knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied						
Programme	Activities, with Key Performance Indicators (KPI) where available	Lead Agency and Partners	Priority	Deadline		Additional provisional budget
				2020	2025	
M-19-01: Effective information sharing	M-19-01-01: CHM used by a broad community of practice and regularly updated for content by concerned stakeholders through collaborative participating means. Subsidiary KPI: number of publications and other resources freely available online, number of working groups and meetings, website visits.	MAIFS as lead agency, with support from MOEMRFS, NPCS and all relevant stakeholders	High	2025		As part of stakeholders' core activities
	M-19-01-02: All biodiversity-related reports funded by public and donor funds are made publicly available in their entirety on the CHM.		High	2017		

National Target 20: By 2017, a financial resources mobilisation strategy and action plan is adopted, targeting all potential public and private sources, leading to substantial increases in biodiversity funding available to implement the NBSAP						
Programme	Activities, with Key Performance Indicators (KPI) where available	Lead Agency and Partners	Priority	Deadline		Additional provisional budget
				2020	2025	
M-20-01: Strategy for Resource Mobilisation	M-20-01-01: Resource mobilisation strategy and action plan developed to fund activities towards reaching the national Aichi Targets.	MFED as lead agency, with support from MAIFS and all partners	High	2017		US$ 85,000
	M-20-01-02: Implementation of the resource mobilisation strategy. Subsidiary KPI: (a) Number of funding applications made to the public and private sectors, as well as development agencies, per national Aichi Target, (b) amounts of funds per Aichi Target allocated and spent from different sources.		High	After 2017	X	Depends on the project

Budget for the Mauritius Biodiversity Action Plan

Target	Prog no	Programme name	Activity no.	Activity name	Budget
1	M-01-01	Comprehensive Coastal & Marine Biodiversity Assessment, Mapping, Valuation, Monitoring, Capacity Building & Education Programme	M-01-01-01	Pilot integrated ecological, cultural & economic valuation studies	$400,000
1			M-01-01-02	Identify gaps	$50,000
1			M-01-01-03	Capacity building & educational programme	$2,500,000
1			M-01-01-04	Assess diverse values	$1,000,000

Target	Prog no	Programme name	Activity no.	Activity name	Budget
2	M-02-01	Biodiversity values mainstreaming in the public sector	M-02-01-01	Assess potential pathways, barriers & opportunities	$130,000
2			M-02-01-02	Start mainstreaming in priority processes	$0
2			M-02-01-03	Update terrestrial, coastal & marine ESA	-
2	M-02-02	Biodiversity values mainstreaming in the private sector	M-02-02-01	Assessment of potential pathways, barriers & opportunities	$150,000
2			M-02-02-02	Start mainstreaming in priority industries	-
3	M-03-01	Phasing out subsidies harmful to biodiversity	M-03-01-01	Study on harmful subsidies, pathways for elimination/phasing out/ reform	$200,000
3			M-03-01-02	Identify incentives favouring the use of IAS	-
3			M-03-01-03	Progressively phase out key harmful subsides	-
3	M-03-02	Setting up sustainable incentives for biodiversity conservation and restoration	M-03-02-01	Secure new funding sources/fiscal incentives	-
3			M-03-02-02	Give CSR grant priority status to projects supporting Aichi Targets	-
3			M-03-02-03	Feasibility study for farmers' compensation scheme to promote CWR & local breeds/cultivars	$100,000
4	M-04-01	Ecosystem services and biodiversity no-net-loss / net gain mainstreaming action plans in the public and private sectors	M-04-01-01	Study on sectoral biodiversity mainstreaming in key target sectors	$250,000
4			M-04-01-02	Adopt sectoral action plans	-
5	M-05-01	Biodiversity values protection, rehabilitation and / or restoration programme	M-05-01-01	Put in place & enforce legal framework for ESA	-
5			M-05-01-02	Effectively manage at least 1,500 ha of PAN	$3,000,000
6	M-06-01	Mainstreaming biodiversity into the management of the coastal and marine zones	M-06-01-01	Ensure that 27,000 ha of marine & coastal ESAs are an integral part of planning & implementation mechanisms in coastal development & the tourism sector	$4,000,000
6			M-06-01-02	Mitigate threats to marine & coastal biodiversity	-
6			M-06-01-03	Study to determine the fish stock & exploitation thresholds	$300,000
6			M-06-01-04	Identify & implement effective measures to improve sustainability of fisheries in EZZ & St Brandon	$1,800,000
6			M-06-01-05	Marine Spatial Plan (MSP) is fully supported and progress achieved.	$750,000
7	M-07-01	Sustainable Agriculture Programme	M-07-01-01	Restore 400 ha of river areas with indigenous species.	$1,200,000
7			M-07-01-02	Assess & set expansion targets for area/population under CWR/local cultivars/breeds	$225,000
7			M-07-01-03	place 25 ha of food crops under the biofarming scheme	-
7			M-07-01-04	2% of food crop growers are certified under the MauriGAP standard	-
7			M-07-01-05	Development of practical guidelines/action plan for domestic & wild pollinators & soil biodiversity conservation & restoration in agriculture	$50,000
7	M-07-02	Sustainable Forestry Programme	M-07-02-01	Develop practical guidelines & action plan for biodiversity conservation & restoration in forestry	$50,000
7			M-07-02-02	Actively manage & restore 2,000 hectares of forest	$6,000,000
7	M-07-03	Sustainable Aquaculture Programme	M-07-03-01	Protect coastal & marine ESA from aquaculture projects	-
7			M-07-03-02	Implement monitoring for water quality & impacts on wild populations	$675,000
8	M-08-01	Comprehensive Freshwater Pollution Minimisation Programme	M-08-01-01	Enforce existing regulations for effluent discharges	-
8			M-08-01-02	Study on human, technological & financial resource needs	$50,000
8			M-08-01-03	Implement monitoring system (biodiversity-related indicators) on water quality	$1,000,000

Target	Prog no	Programme name	Activity no.	Activity name	Budget
8			M-08-01-04	Initiate action to amend the current Chemical Fertiliser Act to incorporate all fertilizers	-
8			M-08-01-05	Fully enact pesticide use regulation	-
8			M-08-01-06	Develop guidelines for the management & disposal of hydroponic effluents	$150,000
8			M-08-01-07	Pollution reduction targets established for non-point source pollution	$300,000
8	M-08-02	Comprehensive Marine Debris	M-08-02-01	Study to identify main pathways for marine debris pollution for offshore islets & outer islands	$300,000
8		Management Programme	M-08-02-02	Develop marine debris strategy & action plan for offshore islets & outer islands	$450,000
9	M-09-01	Implementation of NIASSAP	M-09-01-01	Review & revise NIASSAP	$40,000
9			M-09-01-02	Complete lists of terrestrial & marine invasive species	$30,000
9			M-09-01-03	Identify invasive species pathways	-
9			M-09-01-04	Implement comprehensive risk assessment system	$200,000
9			M-09-01-05	Risk species refused permission for importation/translocation	-
9			M-09-01-06	Improve procedures for controlling unregulated (illegal) importation of species	$2,000,000
9			M-09-01-07	Prioritise for management & where feasible eradication those species present in Mauritius with high invasive potential but still present only in limited areas	$4,000,000
10	M-10-01	Coral reef restoration programme	M-10-01-01	At least 20% of degraded coral reefs in Mauritius are sustainably managed &/or rehabilitated	-
11	M-11-01	Network	M-11-01-01	Declare 20,000 ha of new formal PA	-
11		Management and	M-11-01-02	Management plans for new Pas developed	-
11		Expansion Protected	M-11-01-03	Develop Red List of Ecosystems	$25,000
11		Area	M-11-01-04	Develop guidelines/working criteria for ecosystem restoration/creation for the various ecosystem types	$150,000
11			M-11-01-05	Develop guidelines/working criteria for what constitutes effective conservation management areas	$10,000
11			M-11-01-06	Produce independent METT scores for all PA every 5 years	$30,000
11			M-11-01-07	Manage 1,000 ha of conservation management areas	$1,200,000
11			M-11-01-08	Define restoration & creation targets for highly threatened ecosystem types	$25,000
11	M-11-02	Marine Protected	M-11-02-01	Complete MPA Expansion Strategy & Action Plan	$1,000,000
11		Area Expansion Strategy	M-11-02-02	Implement MPA Expansion Strategy & Action Plan	
12	M-12-01	Terrestrial Threatened Species	M-12-01-01	Complete & /or update the red-listing of Mauritius endemic & indigenous fauna	-
12		Conservation Programme	M-12-01-02	Start the Red-listing process for other taxonomic groups	$100,000
12			M-12-01-03	No species/taxa extinction	-
12			M-12-01-04	Down-listing of 2 Red-Listed animal species & new target defined	-
12			M-12-01-06	Updated or produce new recovery plans in place for threatened bird, reptile, bat, plant & fern species	$250,000
12	M-12-02	Marine Threatened Species Conservation	M-12-02-01	Complete Red-listing of corals, fish, mammals, marine turtles, molluscs, holothurians	$100,000
12		Programme	M-12-02-02	Produce new recovery plans for priority threatened marine species	$250,000
13	M-13-01	Genetic diversity conservation	M-13-01-01	Implement all activities of CWR NSAP	$1,500,000
13			M-13-01-02	Develop a national Red-list & recovery plans for priority local breeds & cultivars	$25,000
13			M-13-01-03	Characterise at least 3-4 taxa (local breeds, races & CWR) per year	-

Target	Prog no	Programme name	Activity no.	Activity name	Budget
13			M-13-01-04	Characterise 10 accessions in National Seed Gene bank per year	-
13			M-13-01-05	Establish & sustainably fund livestock breed conservation scheme	-
13			M-13-01-06	Breed & promote at least two strategic crops	$50,000
13	M-13-02	Marine genetic diversity conservation	M-13-02-01	Study on genetic diversity of priority commercial species	$200,000
13			M-13-02-02	Assess & monitor fish escapees in aquaculture & genetic contamination	$200,000
14	M-14-01	Comprehensive Terrestrial & Freshwater Biodiversity Assessment, Mapping, Valuation, Monitoring, Capacity Building & Education Programme	M-14-01-01	Study on key ecosystem services for key sectors & financial resource needs	$200,000
14			M-14-01-02	Develop & implement a national capacity building programme on ecosystem services management & restoration	$750,000
14			M-14-01-03	Develop a strategy & action plan for priority areas &/or ecosystem services	$200,000
14	M-14-02	Comprehensive Coastal & Marine Biodiversity Assessment, Mapping, Valuation, Monitoring, Capacity Building & Education Programme	M-14-02-01	Study on key ecosystem services for key sectors & financial resource needs	$300,000
14			M-14-02-02	Develop & implement a national capacity building programme on ecosystem services management & restoration	$750,000
14			M-14-02-03	Develop a strategy & action plan for priority areas &/or ecosystem services	$200,000
15	M-15-01	Carbon Stock Enhancement Programme	M-15-01-01	Start in-situ carbon stock assessment & monitoring for different PA	$400,000
15			M-15-01-02	Start in-situ carbon stock assessment & monitoring for different agricultural practices	$400,000
15			M-15-01-03	Develop guidelines & capacity for natural & agricultural ecosystem restoration while minimising carbon loss	$50,000
15			M-15-01-04	Start in-situ carbon stock assessment & monitoring for different marine ecosystems	-
16	M-16-01	Nagoya Protocol Implementation Programme	M-16-01-01	Develop & adopt a legal framework for implementation	$75,000
16			M-16-01-02	Implement pilot projects on legal framework for implementing the Nagoya Protocol	-
17	M-17-01	Mauritius Biodiversity Action Plan	M-17-01-01	Fully endorse NBSAP	-
17			M-17-01-02	Ensure that the NBSAP implementation committee is sustainable	-
17			M-17-01-03	Each partner Ministry & stakeholder is committed to contributing to the national targets	-
17			M-17-01-04	Designation of a responsible officer for coordinating & monitoring the NBSAP by the focal point	-
			M-17-01-05	Draft & sign MoUs by the focal point & lead stakeholders	-
17			M-17-01-06	Effectively mainstream NBSAP into policy & sectors	-
17			M-17-01-07	Review NBSAP in 5 years & amend	$125,000
17			M-17-01-08	Prepare new NBSAP	$250,000
19	M-19-01	Effective information sharing	M-19-01-01	A broad community of practice uses the CHM & it is regularly updated	-
19			M-19-01-02	All biodiversity-related reports funded by public & donor funds are made publicly available ion the CHM	-
20	M-20-01	Strategy for Resource Mobilisation	M-20-01-01	Develop resource mobilisation strategy & action plan	$85,000
20			M-20-01-01	Implement resource mobilisation strategy	-
Total					**$40,250,000**

3.2 Rodrigues Biodiversity Action Plan:

This following Biodiversity Action Plan applies to Rodrigues, its islets and the associated coastal and marine areas.

National Target 1: By 2025, the diverse set of key biodiversity values of priority areas / taxa and steps to conserve and use them sustainably have been assessed and are being monitored in an integrated manner for awareness raising and fully-informed decision making						
Programme	Activities, with Key Performance Indicators (KPI) where available	Lead Agency and Partners	Priority	Deadline		Additional provisional budget
				2020	2025	
R-01-01: Comprehensive Terrestrial, Freshwater, Coastal and Marine Biodiversity Assessment, Mapping, Valuation, Monitoring, Capacity Building & Education Programme	R-01-01-01: Pilot integrated ecological, cultural and economic valuation studies undertaken at several sites, including potentially priority cascades (Cascade Pigeon, Mourouk, Saint-Louis), coastal zone, the lagoon and islets (Ile-aux-Cocos, Ile Gombrani and Ile au Sable).	RRA (FS, Fisheries), Shoals, MWF, SEMPA, Commission for tourism, Commission for Environment	High	X		US$ 300,000
	R-01-01-02: Gaps identified, resource needs assessed, funding secured for the whole project.		High	X		US$ 25,000
	R-01-01-03: A comprehensive capacity building and educational programme is developed and implemented for the benefits of the public and private sectors, including fisheries, forestry and tourism sectors, building on existing educational / awareness raising work and the latest research and good practices. Subsidiary KPI: Number of Master and PhD students and valuation-related jobs, number of people trained, awareness survey results.		High		X	US$500, 000
	R-01-01-04: The diverse values (cultural, ecological, economic) of the priority areas are assessed in qualitative, quantitative and monetary terms and strategies / action plans with quantified targets (e.g. per site) are identified and implemented to restore degraded or lost values. Subsidiary KPI: Proportion of PA, ESA and taxa covered.		Medium		X	Incorporated first Target 1 activity
R-01-02: Comprehensive Agro-Biodiversity Assessment, Mapping, Valuation, Monitoring, Capacity Building & Education Programme	R-01-02-01: Study of the status and values of domesticated and wild pollinators and steps needed to conserve them completed, including resource needs (human, technological, financial) assessment.	RRA (CoA)	High	X		US$ 150,000
	R-01-02-02: Study of the status and values of soil biodiversity and steps needed to conserve it completed, including resource needs (human, technological, financial) assessment.		High	X		US$ 200,000
	R-01-02-03: Comprehensive study on traditional knowledge, innovations and practices compiled and pathways identified to conserve and promote them, including resource needs (human, technological, financial) assessment.		High	X		US$ 100,000
	R-01-02-04: The ecological, social and economic values of priority local breeds / cultivars are assessed and pathways to conserve and use them sustainably are identified, including resource needs (human, technological, financial) assessment.		High	X		US$ 300,000

National Target 1: By 2025, the diverse set of key biodiversity values of priority areas / taxa and steps to conserve and use them sustainably have been assessed and are being monitored in an integrated manner for awareness raising and fully-informed decision making						
	Monitoring system is designed and implemented, results widely shared, free-of-charge to all, on a regular basis and significant progress is made in raising awareness and reducing knowledge gaps. Subsidiary KPI: Population size, surface area cultivated, market value, cultural uses, genetic diversity characteristic, number of jobs, number of awareness-raising campaigns, number of farmers and school children trained and / or educated, number of action plans, expenses per CWR, local breed / cultivar.		Medium		X	

National Target 2: By 2025, practical pathways are identified and various tools help integrate the diverse set of biodiversity values in public and private policy and decision-making, planning, production, accounting and reporting processes						
Programme	Activities, with Key Performance Indicators (KPI) where available	Lead Agency and Partners	Priority	Deadline		Additional provisional budget
				2020	2025	
R-02-01: Biodiversity values mainstreaming in the private sector	R-02-01-01: Assessment of potential pathways, barriers and opportunities for biodiversity values mainstreaming in private policy and decision-making, planning, production, accounting and reporting processes. NB: Assessment covers agro-biodiversity, terrestrial, freshwater, coastal and marine ecosystems.	Chamber of Commerce, company associations (ATR), RRA	High	X		US$ 50,000
	R-02-01-02: Mainstreaming is starting in priority industries (e.g. tourism, agriculture, landscaping, construction, infrastructure development, fisheries, terrestrial and ocean mining), in terms of corporate policies, strategies and practices. Subsidiary KPI: Number of companies engaged in biodiversity mainstreaming, types of mainstreaming activities initiated, company disclosures (impacts and dependencies), number of biodiversity-related jobs created in the private sector.		Medium		X	Embedded in future activities (stakeholders to be determined)

National Target 3: By 2025, the incentives, including subsidies, harmful to biodiversity across all sectors have been assessed and practical pathways for incentives to reward pro-biodiversity practices and outcomes by all stakeholders, including the private sector, are being implemented						
Programme	Activities, with Key Performance Indicators (KPI) where available	Lead Agency and Partners	Priority	Deadline		Additional provisional budget
				2020	2025	
R-03-01: Phasing out subsidies harmful to biodiversity	R-03-01-01: Study on harmful subsidies, pathways for their elimination, phasing out or reform and potential positive incentives (e.g. including how to sustain existing schemes, such as CSR, and make them focus on projects contributing to the Aichi Targets) for the conservation and sustainable use of biodiversity completed. NB: Assessment covers agro-biodiversity, terrestrial, freshwater, coastal and marine ecosystems, as well as key sectors such as tourism, property development, fisheries, agriculture, infrastructure, ocean mining, government ministries and local authorities.	RRA as lead agency, with support from all relevant ministries and stakeholders	High	X		US$ 50,000
	R-03-01-02: Incentives favouring the use, cultivation or dissemination of species that are known to be invasive in Rodrigues or suspected of becoming invasive (based on risk assessment) are clearly identified and documented, such incentives are in the process of being phased out, and, as far as possible, are replaced by incentives for the prevention and control of such species. <u>Subsidiary KPI:</u> Report on incentives with specific recommendations.		High	X		Embedded in future activities (stakeholders to be determined)
	R-03-01-03: Key harmful subsides are progressively phased out.		Medium		X	
R-03-02: Setting up sustainable incentives for biodiversity conservation and resto- ration	R-03-02-01: New sustainable funding sources (e.g. non-sinking funds) and fiscal incentives secured (e.g. from phased out harmful subsidies) to reward pro-biodiversity actions, outcomes and / or stewardship / restoration, notably nominal annual rental fees for business activities contributing to ecosystem restoration. NB: Covers terrestrial, freshwater, coastal and marine biodiversity.		Medium		X	
	R-03-02-02: Projects supporting Aichi Targets are given priority status by the GoM in CSR grants by companies.		High	2017	2025	

National Target 4: By 2025, sectoral biodiversity mainstreaming plans in partnership with the target stakeholders in key economic sectors as guiding principles in existing and new development projects, and are based (a) on recreating resilient ecosystems and their capacity to supply a wide variety of ecosystem services and (b) on adopting no net loss and (ideally) net gains of biodiversity values						
Programme	Activities, with Key Performance Indicators (KPI) where available	Lead Agency and Partners	Priority ranking	Deadline		Additional provisional budget
				2020	2025	
R-04-01: Ecosystem services and biodiversity no-net-loss / net gain mainstreaming action plans in the public and private sectors	R-04-01-01: Study on sectoral biodiversity mainstreaming in key target sectors (e.g. tourism, property development, financial services, fisheries, ocean mining, agriculture, infrastructure, local authority services, national government ministries) completed, with focus on barriers and opportunities for ecosystem services stewardship and adoption of biodiversity no-net-loss / net gain policy.	RRA leading, with support from all relevant ministries and stakeholders	Medium	X		US$ 75,000
	R-04-01-02: Sectorial action plans adopted and are being implemented, focusing on ecosystem restoration / rehabilitation and no-net loss / net gains of biodiversity values as underlying principles for all new projects.		Medium		X	Embedded in future activities (stakeholders to be determined)

National Target 5: By 2025, the loss of natural habitats is halted and ecological integrity of significant areas of degraded and fragmented habitats is restored, focusing on an expanded PAN and ESA						
Programme	Activities, with Key Performance Indicators (KPI) where available	Lead Agency and Partners	Priority	Deadline		Additional provisional budget
				2020	2025	
R-05-01: Biodiversity values protection, rehabilitation and / or restoration programme	R-05-01-01: Legal framework for ESA is in place and enforced (i.e. no further loss of ecosystems such as coral reefs, forests and wetlands).	RRA (FS), Francois Leguat Reserve, MWF	High	X		-
	R-05-01-02: At least 200 ha effectively managed for ecological integrity and new targets set for 2025.		High	X		US$ 450,000

National Target 6: By 2025, the sustainable management, harvesting and / or recovery of priority marine and freshwater resources is achieved						
Programme	Activities, with Key Performance Indicators (KPI) where available	Lead Agency and Partners	Priority	Deadline		Additional provisional budget
				2020	2025	
R-06-01: Mainstreaming biodiversity into the management of the coastal and marine zones	R-06-01-01: Threats to biodiversity and ecosystem function are addressed by ensuring that 27,000 ha of marine and coastal Environmentally Sensitive Areas (ESAs) are an integral part of planning and implementation mechanisms relating to coastal development and the tourism sector.	RRA (FS), FRTU, SEMPA, Shoals	High	X		US$ 800,000 (excluding co-funding, to be shared with Mauritius)
	R-06-01-02: Threats to marine and coastal biodiversity are mitigated and fishery resources protected in at least 20,000 ha of seascapes, through the improved management of MPAs and the development of no-take zones.		High	X		
	R-06-01-03: Study to determine the fish stocks and exploitation thresholds of coastal and marine resources, including the assessment of the sustainability of fisheries in EEZ.		High	X		US$ 250,000
	R-06-01-04: Monitoring system and effective measures identified and implemented to improve sustainability of lagoon and off-lagoon fisheries. Subsidiary KPI: Catch per unit effort / species, size, weight, transect-based monitoring (population density).		Medium		X	US$ 100,000 / year

National Target 7: By 2025, a pro-active policy framework, with incentives for pro-biodiversity practices and disincentives for harmful practices, is developed and implemented.						
Programme	Activities, with Key Performance Indicators (KPI) where available	Lead Agency and Partners	Priority	Deadline		Additional provisional budget
				2020	2025	
R-07-01: Organic Agriculture Programme	R-07-01-01: Development of financing scheme (opportunity costs, including transition period) to promote soil and water conservation, organic farming, promotion of CWR and local breeds / cultivars.	MAIFS as lead agency, with support from FS, private sector, FAREI	High	X		US$ 175,000 / year
	R-07-01-02: Surface area and / or population size cultivated with CWR, local cultivars and breeds updated and expansion target per type established.		High	X		US$ 100,000
	R-07-01-03: 500 ha of food crops under the organic agriculture scheme.		High		X	Project dependent
	R-07-01-04: 50% of farmers are certified organic, production volumes are assessed and new expansion targets are defined and adopted.		High	X		
	R-07-01-05: Development of practical guidelines and action plan for domestic and wild pollinators, water and soil biodiversity conservation and restoration in agriculture (food, livestock).		High	X		US$ 75,000
R-07-02: Sustainable Forestry Programme	R-07-02-01: Development of practical guidelines, action plan and training for biodiversity conservation and restoration in forestry.	Forestry Service, local communities, NGOs	High	X		US$ 250,000
	R-07-02-02: 500 hectares of new native forests under active management and restoration.		High		X	US$ 1.25 m
R-07-03: Sustainable Aquaculture Programme	R-07-03-01: Coastal and marine ESA areas protected from aquaculture.	RRA (FPS, FRTU, SEMPA), MRC, Shoals	High	X		-
	R-07-03-02: Monitoring system in place to monitor water quality and impacts on wild populations.		High	X	2025	US$ 30,000 / year

National Target 8: By 2025, a pro-biodiversity pollution minimisation strategy, focusing on the restoration of freshwater systems (from mountains / catchment to sea) and on reducing water use and emissions, including nutriments, is set up and implemented across sectors						
Programme	Activities, with Key Performance Indicators (KPI) where available	Lead Agency and Partners	Priority	Deadline		Additional provisional
				2020	2025	
R-08-01: Comprehensive Freshwater, Coastal & Marine Pollution Minimisation Programme	R-08-01-01: Enforcement of existing regulations for effluent discharges. Subsidiary KPI: Number and extent of violations, actions taken and complaints.	RRA (WRU, REU)	High	X		Ongoing
	R-08-01-02: Study on human (capacity, skills, knowledge), technological and financial resource needs completed.		High	X		US$ 80,000
	R-08-01-03: Monitoring system (biodiversity-related indicators) on water quality for human, industrial, agricultural and ecosystem purposes in place for point and non-point source pollution per catchment established.		Medium		X	US$ 500,000
	R-08-01-04: Catchment Management Committees established, pollution reduction targets established for non-point and point source pollution in each catchment based on broad stakeholder agreement, time-bound commitments and budgets.		Medium		X	US$ 1 million

National Target 9: By 2025, the NIASSAP is revised and fully implemented through adequate financial and human resources commensurate to the existing challenges and the impacts caused by IAS are minimised					
Programme: Implementation of NIASSAP (R-09-01) Activities, with Key Performance Indicators (KPI) where available	Lead Agency & Partners	Priority ranking	Deadline		Additional provisional budget
			2020	2025	
R-09-01-01: Development of RIASSAP, with progress assessed, gaps identified (inc. marine IAS) and activities fully costed with precise timeline for implementation for both terrestrial and marine IAS.	RRA (FS, REU, FPS, FRTU), MWF	High	X		US$ 50,000
R-09-01-02: Up-to-date lists of terrestrial and marine invasive species of all taxa present in Rodrigues completed and publicly available, and a system for their regular updating is in place and is being used. Subsidiary KPI: species lists online		High	2025		US$ 15,000
R-09-01-03: Pathways of introduction of new species into Rodrigues and between its islets are identified, their relative importance is quantified, and they are prioritised for management action to reduce the rate of arrival of new species. Subsidiary KPI: Published document identifying pathway importance, with specific management recommendations and action plan adopted and implemented for the improved management of the major pathways identified as priorities due to their high potential for the introduction of invasive species to the Rodrigues or between its islets.		High	2025		
R-09-01-04: A comprehensive risk assessment system is in place and being used in Rodrigues, to (1) assess the risks that new species proposed for importation to the RoM or moved between its islands may become invasive (border control), and (2) assess the risks associated with species already present in the RoM but which may not yet have become invasive there (management prioritisation). Subsidiary indicators: (1) Risk assessment system in use for border control (proposed imports and translocations between islands for all taxa); (2) risk assessment system for introduced plants (at least) that are already present in RoM, developed and in use.		High	2025		US$ 100,000
R-09-01-05: Species identified by formal risk assessment as having high invasiveness potential in Rodrigues are refused permission for importation or for translocation between its islets. Subsidiary indicators: Reports on outcomes of applications for permission to import/transport.		High	2025		-
R-09-01-06: Procedures for controlling the unregulated (illegal) importation of species to Rodrigues (including for aquaculture) or between its islets are improved (effective quarantine system with sanctions for deliberate infractions). Subsidiary indicators: Improved traveller/importer awareness; improved port-of-entry inspection procedures; number of fines / sanctions.		High	2025		US$ 750,000
R-09-01-07: Species present in Rodrigues, with high invasive potential but still present only in limited areas, are prioritised for management and where feasible eradication, by means of a formal risk assessment process, including, as far as possible, their declaration as “harmful”, “prohibited”, or similar. Subsidiary indicators: List of potential high-priority management targets; number of species managed; management plans for priority species developed & implemented; number of hectares cleared per target species.		High	2025		US$ 482,500

National Target 10: By 2025, the loss of natural habitats is halted and ecological integrity of significant areas of degraded and fragmented habitats is restored, focusing on an expanded PAN and ESA						
Programme	Activities, with Key Performance Indicators (KPI) where available	Lead Agency and Partners	Priority	Deadline		Additional provisional budget
				2020	2025	
Coral reef restoration programme	At least 20% of degraded coral reefs in Rodrigues are sustainably managed and / or rehabilitated.	RRA (SEMPA, FRTU, FPS), Shoals	High	X		Embedded in other activities

National Target 11: By 2025, at least 16 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes						
Programme	Activities, with Key Performance Indicators (KPI) where available	Lead Agency & Partners	Priority	Deadline		Additional provisional budget
				2020	2025	
Terrestrial Protected Area Network Management and Expansion (R-11-01)	R-11-01-01: Rodrigues Protected Area Expansion Strategy and Action Plan developed with quantified targets by 2020 and new protected areas declared by 2025, including on islets.	RRA (FS), MWF, Francois Leguat Reserve	High	Continuous		US$ 250,000
	R-11-01-02: Management plans for new formal protected areas developed and implemented.		High	Continuous		US$ 25,000 / protected area
	R-11-01-03: Develop a Red List of ecosystems for Rodrigues (2020) and update it (2025).		High	X	X	US$ 12,500
	R-11-01-04: Develop guidelines and working criteria for ecosystem restoration / creation for the various ecosystem types.		Med	X		US$ 50,000
	R-11-01-05: Independent management effectiveness scores for all PA carried out every 5 years, including over planning, financial sustainability, ecological integrity & resource use.		High	Continuous		US$ 5,000 to 15,000 per assessment
	R-11-01-06: Restoration and creation targets established for highly threatened ecosystem types.		High	X		US$ 25,000
Marine Protected Area Management (R-11-02)	R-11-02-01: Setting up a MPA Management Authority with full powers & sufficient budget to effectively manage the MPA.	RRA (FPS, SEMPA), RCSS, Shoals, fishermen, tourism operators	High	X		US$ 150,000 / year
	R-11-02-02: Develop guidelines and working criteria for ecosystem restoration / creation for the various marine ecosystem types, including but not limited to coral reefs and seagrass meadows.		High	X		US$ 100,000
	R-11-02-03: Independent management effectiveness scores for all MPA carried out every 5 years, including over planning, financial sustainability, ecological integrity and resource use aspects.		High			US$ 5,000- 15,000/ assessment

	R-11-02-04: Develop a Red List of marine ecosystems for Rodrigues (2020) and update it (2025).		High		US$ 25,000
	R-11-02-05: Management plans reviewed every 5 years and fully implemented.		High		US$ 5,000 / management

National Target 12: By 2020, the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained						
Programme	Activities, with Key Performance Indicators (KPI) where available	Lead Agency & Partners	Priority	Deadline		Additional provisional budget
				2020	2025	
R-12-01: Terrestrial Threatened Species Conservation Programme	R-12-01-01: Complete and / or update the Red Listing of Rodrigues endemic and indigenous fauna (inc. reptiles and land mammals) and flora (including CWR) species.	FS, MWF	High	X		-
	R-12-01-02: No species / taxa extinction.		High	2025		-
	R-12-01-03: Down listing of 1 Red-Listed animal species and new target defined.		High	X		-
	R-12-01-04: Updated or new recovery plans in place for threatened bird, reptile, bat, plant and fern species.		Medium	X		US$ 50,000
R-12-02: Marine Threatened Species Conservation Programme	R-12-02-01: Complete Red-Listing of priority marine species by 2020, regularly update afterwards.	RRA (FPS, FRTU, SEMPA), Shoals	High	X	Continuous	US$ 100,000
	R-12-02-02: New recovery plans in place for priority threatened marine species.		Medium		X	US$ 100,000

National Target 13: By 2020, the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained						
Programme	Activities, with Key Performance Indicators (KPI) where available	Lead Agency & Partners	Priority	Deadline		Additional provisional budget
				2020	2025	
R-13-01: Genetic diversity conservation	R-13-01-01: All Rodrigues-related activities of CWR NSAP implemented.	UoM, MAIFS, FAREI	High	2025		US$ 150,000
	R-13-01-02: Develop a Red-List and recovery and / or expansion plans for priority local breeds and cultivars.		High	X		US$ 25,000
	R-13-01-03: Develop a Rodrigues gene bank.		High	Continuous		US$ 150,000
	R-13-01-04: At least two strategic crops are bred and promoted (e.g. red bean, lime, chili, garlic).		High	2018, 2025		US$ 20,000 / year
R-13-02: Marine genetic diversity assessment programme - Assessment of status quo	Study on genetic diversity of priority commercial species (fish, sea cucumbers, molluscs).	MOEMRFS, MOI	High	X		US$ 150,000
	Assessment and monitoring measures of fish escapees in aquaculture and genetic contamination.		High	X		US$ 100,000

National Target 14: By 2025, ecosystems that provide essential services, including services related to water, and contribute to health and well-being, are restored and safeguarded, taking into account the needs of women and local communities, and the poor and vulnerable.						
Programme	Activities, with Key Performance Indicators (KPI) where available	Lead Agency & Partners	Priority	Deadline		Additional provisional budget
				2020	2025	
R-14-01: Comprehensive Terrestrial, Freshwater, Coastal and Marine Biodiversity assessment, Mapping, Valuation, Monitoring, Capacity Building & Education Programme	R-14-01-01: Study on key ecosystem services (supply, demand, risk) for key sectors completed, including tourism and agriculture, and including human (capacity, skills, knowledge) and financial resource needs.	RRA (FS, FRTU, RTO, REU, SEMPA, WRU), MWF, Shoals	High	X		US$ 250,000
	R-14-01-02: Development and implementation of a Rodrigues capacity building programme on ecosystem services management and restoration. Subsidiary KPI: Number of Master and PhD students and valuation-related jobs, number of people training, awareness survey results.		High	X		US$ 400,000
	R-14-01-03: Development of strategy and action plan for priority areas and / or ecosystem services.		Medium		X	US$ 100,000

National Target 15: By 2025, steps for enhancing ecosystem resilience and the contribution of biodiversity to carbon stocks are undertaken, focusing on conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation						
Programme	Activities, with Key Performance Indicators (KPI) where available	Lead Agency and Partners	Priority rank-	Deadline		Additional provisional budget
				2020	2025	
R-15-01: Carbon Stock Enhancement Programme	R-15-01-01: In-situ carbon stock assessment and monitoring starts for different sites (Tons CO_2 eq.), differentiating between different types of forests (native vs exotic).	FS, MWF	Medium	X	Continuous	US$ 125,000
	R-15-01-02: Rodrigues integrated in the development of national guidelines and capacity for natural and agricultural ecosystem restoration while minimising carbon loss.		Medium	X		US$ 50,000

National Target 16: By 2020, a legal framework for implementing the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilisation is adopted, and by 2025 best practice case studies are showcased						
Programme	Activities, with Key Performance Indicators (KPI) where available	Lead Agency and Partners	Priority	Deadline		Additional provisional budget
				2020	2025	
R-16-01: Nagoya Protocol Implementation Programme	Pilot projects successfully implemented.		Medium		X	Project dependent (private sector funding)

National Target 17: By 2020, the NBSAP is adopted and mainstreamed in all relevant policies and legislations and is fully funded, monitored and implemented to achieve the Aichi Targets						
Programme	Activities, with Key Performance Indicators (KPI) where available	Lead Agency and Partners	Priority	Deadline		Additional provisional budget
				2020	2025	
R-17-01: Rodrigues Action Plan	R-17-01-01: RAP is fully endorsed by Executive Council of RRA and REC.	RRA as the focal point and coordinator with support from all stakeholders	High	Continuous		-
	R-17-01-01: RAP implementation committee, potentially within REC, is sustainable (meeting every 3 months) and involves all key stakeholders.		High	2025		
	R-17-01-01: Executive Council of RRA, each partner commission and stakeholder is committed to contributing to the Rodrigues targets (budget, expenses, project KPI).		High	2025		
	R-17-01-01: The focal point designates, on a full-time basis, a responsible officer for coordinating and monitoring the RAP, and each KPI is monitoring on a quarterly basis.		Medium	Immediately		
	R-17-01-01: MoU are drafted and signed by the focal point and lead stakeholders responsible for implementing each Rodrigues target		High	X		
	R-17-01-01: The RAP is effectively mainstreamed into policy and sectors (number of documented changes in policy and / or practice).		High	2025		
	R-17-01-01: RAP is reviewed in 5 years and amended through a fully participative consultation process.		High	X		US$ 25,000
	R-17-01-01: A new RAP is prepared through a fully participative consultation process.		Medium		X	US$ 50,000

National Target 19: By 2020, knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied						
Programme	Activities, with Key Performance Indicators (KPI) where available	Lead Agency and Partners	Priority	Deadline		Additional provisional budget
				2020	2025	
R-19-01: Effective information sharing	R-19-01-01: CHM webpages on Rodrigues used by a broad community of practice and regularly updated for content by concerned stakeholders through collaborative participative means. Subsidiary KPI: Number of publications and other resources freely available online, number of working groups.	RRA and all relevant stakeholders	High	2025		-
	R-19-01-02: All biodiversity-related reports in Rodrigues funded by public and donor funds are made publicly available in their entirety on the CHM.		High	2017		

National Target 20: By 2017, a financial resources mobilisation strategy and action plan is adopted, targeting all potential public and private sources, leading to substantial increases in biodiversity funding available to implement the NBSAP						
Programme	Activities, with Key Performance Indicators (KPI) where available	Lead Agency and Partners	Priority	Deadline		Additional provisional budget
				2020	2025	
R-20-01: Rodrigues Strategy for Resource Mobilisation	R-20-01-01: Rodrigues resource mobilisation strategy and action plan developed to fund activities towards reaching the nation Aichi Targets.	RRA (EPMU), all partners	High	2017		US$ 25,000
	R-20-01-02: Implementation of the Rodrigues resource mobilisation strategy Subsidiary KPI: (a) number of funding applications made to the public and private sectors, as well as development agencies, per national Aichi Target, (b) amounts of funds per Aichi Target allocated and spent from different sources.		High	After 2017	X	Depends on the project

Budget for the Rodrigues Biodiversity Action Plan

Target	Prog no	Programme name	Activity no.	Activity name	Budget
1	R-01-01	Comprehensive Coastal & Marine Biodiversity Assessment, Mapping, Valuation, Monitoring, Capacity Building & Education Programme	R-01-01-01	Pilot integrated ecological, cultural & economic valuation studies	$300,000
1			R-01-01-02	Identify gaps	$25,000
1			R-01-01-03	Capacity building & educational programme	$500,000
1			R-01-01-04	Assess diverse values	-
1	R-01-02	Comprehensive Agro-Biodiversity Assessment, Mapping, Valuation, Monitoring, Capacity Building & Education Programme	R-01-02-01	Study of the status and values of domesticated and wild pollinators and steps needed to conserve them	$150,000
1			R-01-02-02	Study of the status and values of soil biodiversity and steps needed to conserve it	$200,000
1			R-01-02-03	Comprehensive study on traditional knowledge, innovations and practices compiled and pathways identified to conserve and promote them	$100,000
1			R-01-02-04	Assessment of the ecological, social and economic values of priority local breeds/cultivars and pathways to conserve and use them sustainably	$300,000
2	R-02-01	Biodiversity values mainstreaming in the private sector	R-02-01-01	Assessment of potential pathways, barriers & opportunities	$50,000
2			R-02-01-02	Start mainstreaming in priority industries	-
3	R-03-01	Phasing out subsidies harmful to biodiversity	R-03-01-01	Study on harmful subsidies, pathways for elimination/phasing out/ reform	$50,000
3			R-03-01-02	Identify incentives favouring the use of IAS	-
3			R-03-01-03	Progressively phase out key harmful subsides	-
3	R-03-02	Setting up sustainable incentives for biodiversity conservation and restoration	R-03-02-01	Secure new funding sources/fiscal incentives	-
3			R-03-02-02	Give CSR grant priority status to projects supporting Aichi Targets	-

Target	Prog no	Programme name	Activity no.	Activity name	Budget
4	R-04-01	Ecosystem services and biodiversity no-net-loss / net gain mainstreaming action plans in the public and private sectors	R-04-01-01	Study on sectoral biodiversity mainstreaming in key target sectors	$75,000
4			R-04-01-02	Adopt sectoral action plans	-
5	R-05-01	Biodiversity values protection, rehabilitation and / or restoration programme	R-05-01-01	Put in place & enforce legal framework for ESA	-
5			R-05-01-02	Effectively manage at least 200 ha for ecological integrity	$450,000
6	R-06-01	Mainstreaming biodiversity into the management of the coastal and marine zones	R-06-01-01	Ensure that 27,000 ha of marine & coastal ESAs are an integral part of planning & implementation mechanisms in coastal development & the tourism sector	$800,000
6			R-06-01-02	Mitigate threats to marine & coastal biodiversity	-
6			R-06-01-03	Study to determine the fish stock & exploitation thresholds	$250,000
6			R-06-01-04	Identify & implement effective measures to improve sustainability of fisheries in EEZ	$900,000
7	R-07-01	Organic Agriculture Programme	R-07-01-01	Develop financing scheme to promote soil and water conservation, organic farming, CWR & local breeds/cultivars	$1,575,000
7			R-07-01-02	Assess & set expansion targets for area/population under CWR/local cultivars/breeds	$100,000
7			R-07-01-03	Place 500 ha of food crops under the organic agriculture scheme	-
7			R-07-01-04	50% of farmers are certified organic, production volumes are assessed and new expansion targets are defined and adopted.	-
7			R-07-01-05	Development of practical guidelines/action plan for domestic & wild pollinators & soil biodiversity conservation & restoration in agriculture	$75,000
7	R-07-02	Sustainable Forestry Programme	R-07-02-01	Develop practical guidelines & action plan for biodiversity conservation & restoration in forestry	$250,000
7			R-07-02-02	Actively manage & restore 500 hectares of forest	$1,250,000
7	R-07-03	Sustainable Aquaculture Programme	R-07-03-01	Protect coastal & marine ESA from aquaculture projects	-
7			R-07-03-02	Implement monitoring for water quality & impacts on wild populations	$270,000
8	R-08-01	Comprehensive Freshwater Pollution Minimisation Programme	R-08-01-01	Enforce existing regulations for effluent discharges	-
8			R-08-01-02	Study on human, technological & financial resource needs	$80,000
8			R-08-01-03	Implement monitoring system (biodiversity-related indicators) on water quality	$500,000
8			R-08-01-04	Establish Catchment Management Committees , pollution reduction targets for non-point and point source pollution in each catchment	$1,000,000
9	R-09-01		R-09-01-01	Develop RIASSAP	$50,000

Target	Prog no	Programme name	Activity no.	Activity name	Budget
9		Implementation of NIASSAP	R-09-01-02	Complete lists of terrestrial & marine invasive species	$15,000
9			R-09-01-03	Identify invasive species pathways	-
9			R-09-01-04	Implement comprehensive risk assessment system	$100,000
9			R-09-01-05	Risk species refused permission for importation/translocation	-
9			R-09-01-06	Improve procedures for controlling unregulated (illegal) importation of species	$750,000
9			R-09-01-07	Prioritise for management & where feasible eradication those species present in Mauritius with high invasive potential but still present only in limited areas	$482,500
10	R-10-01	Coral reef restoration programme	R-10-01-01	At least 20% of degraded coral reefs in Rodrigues are sustainably managed &/or rehabilitated	-
11	R-11-01	Network Management and Expansion Protected Area	R-11-01-01	Develop Rodrigues Protected Area Expansion Strategy and Action Plan developed and declare new protected areas	$250,000
11			R-11-01-02	Management plans for new PAs developed	$100,000
11			R-11-01-03	Develop Red List of Ecosystems	$12,500
11			R-11-01-04	Develop guidelines/working criteria for ecosystem restoration/creation for the various ecosystem types	$50,000
11			R-11-01-05	Produce independent METT scores for all PA every 5 years	$60,000
11			R-11-01-06	Produce restoration and creation targets for highly threatened ecosystem types.	$25,000
11	R-11-02	Marine Protected Area Expansion Strategy	R-11-02-01	Set up a MPA Management Authority	$1,350,000
11			R-11-02-02	Develop guidelines and working criteria for ecosystem restoration / creation for the various marine ecosystem types	$100,000
11			R-11-02-03	Produce independent METT scores for all PA every 5 years	$50,000
11			R-11-02-04	Develop a Red Lst of marine ecosystems for Rodrigues	$25,000
11			R-11-02-05	Review management plans	$50,000
12	R-12-01	Terrestrial Threatened Species Conservation Programme	R-12-01-01	Complete & /or update the red-listing of Rodrigues endemic & indigenous fauna and CWR	-
12			R-12-01-02	No species/taxa extinction	-
12			R-12-01-03	Down-listing of 1 Red-Listed animal species & new target defined	-
12			R-12-01-04	Updated or produce new recovery plans in place for threatened bird, reptile, bat, plant & fern species	$50,000
12	R-12-02	Marine Threatened Species Conservation Programme	R-12-02-01	Complete Red-listing of priority marine species	$100,000
12			R-12-02-02	Produce new recovery plans for priority threatened marine species	$100,000
13	R-13-01	Genetic diversity conservation	R-13-01-01	Implement all Rodrigues-related activities of CWR NSAP	$150,000
13			R-13-01-02	Develop a Red-List & recovery plans for priority local breeds & cultivars	$25,000

Target	Prog no	Programme name	Activity no.	Activity name	Budget
13			R-13-01-03	Develop a Rodrigues gene bank	$150,000
13			R-13-01-04	Breed & promote at least two strategic crops	$180,000
13	R-13-02	Marine genetic diversity conservation - assessment of status quo	R-13-02-01	Study on genetic diversity of priority commercial species	$150,000
13			R-13-02-02	Assess & monitor fish escapees in aquaculture & genetic contamination	$100,000
14	R-14-01	Comprehensive Terrestrial, Freshwater, Coastal and Marine Biodiversity assessment, Mapping, Valuation, Monitoring, Capacity Building & Education Programme	R-14-01-01	Study on key ecosystem services for key sectors & financial resource needs	$250,000
14			R-14-01-02	Develop & implement a Rodrigues capacity building programme on ecosystem services management & restoration	$400,000
14			R-14-01-03	Develop a strategy & action plan for priority areas &/or ecosystem services	$100,000
15	R-15-01	Carbon Stock Enhancement Programme	R-15-01-01	Start in-situ carbon stock assessment & monitoring for different sites	$125,000
15			R-15-01-02	Integrate Rodrigues in national guidelines & capacity for natural & agricultural ecosystem restoration while minimising carbon loss	$50,000
16			R-16-01-01	Implement pilot projects on legal framework for implementing the Nagoya Protocol	-
17	R-17-01	Rodrigues Action Plan	R-17-01-01	Fully endorse RAP	-
17			R-17-01-02	Ensure that the RAP implementation committee is sustainable	-
17			R-17-01-03	Each partner Commission & stakeholder is committed to contributing to the national targets	-
17			R-17-01-04	Designation of a responsible officer for coordinating & monitoring the RAP by the focal point	-
17			R-17-01-05	Draft & sign MoUs by the focal point & lead stakeholders	-
17			R-17-01-06	Effectively mainstream RAP into policy & sectors	-
17			R-17-01-07	Review RAP in 5 years & amend	$25,000
17			R-17-01-08	Prepare new RAP	$50,000
19	R-19-01	Effective information sharing	R-19-01-01	A broad community of practice uses the CHM pages on Rodrigues & it is regularly updated	-
19			R-19-01-02	All biodiversity-related reports in Rodrigues funded by public & donor funds are made publicly available ion the CHM	-
20	R-20-01	Strategy for Resource Mobilisation	R-20-01-01	Develop Rodrigues resource mobilisation strategy & action plan	$25,000
20			R-20-01-01	Implement Rodrigues resource mobilisation strategy	-
Total					**$14,750,000**

4 GAPS IDENTIFIED FOR IMPLEMENTING NATIONAL TARGETS

4.1 Plan for capacity development for NBSAP implementation

The preparatory study "*Advances in cross-sectoral mainstreaming of biodiversity in Mauritius*" has identified several key knowledge and human capacity / skills gaps in:

- Biodiversity and ecosystem services assessment, mapping and valuation in qualitative, quantitative and economic terms, for the terrestrial, freshwater, coastal, marine and agro-biodiversity (national target 1);
- Biodiversity-focused freshwater monitoring (national target 8);
- Biosecurity and IAS management (national target 9);
- Ecosystem services management and rehabilitation / restoration (national target 14);
- Natural and agricultural ecosystem rehabilitation / restoration (national targets 6 and 7) while minimising carbon loss (national target 14).

For each identified gap, comprehensive capacity building targeting both the public, and private sectors and NGOs are intended to be completed by 2020 (see relevant sub-sections of the Mauritius Action Plan (MAP) and Rodrigues Action Plan (RAP) so as to reduce the reliance on foreign expertise.

4.2 Communication and outreach strategy for the NBSAP

Cooperation between stakeholders is critical for the effective communication and outreach strategy NBSAP. With the support of the National Focal Point (NFP), the Permanent Secretary of the Ministry of Agro-Industry and Food Security (MAIFS), this responsibility to communicate about its contributions to the NBSAP and national targets lies with each implementing agency, notably members of the three NBSAP working groups (i.e. Terrestrial Biodiversity Working Group, Agro-biodiversity Working Group and Freshwater, Coastal and Marine Working Group) in Mauritius and the various stakeholder in Rodrigues (various departments of the RRA, MWF).

In addition, various monitoring systems are to be set in place, with results widely shared, free-of-charge to all, on a regular basis on the CHM (see section 5.2) so that significant progress is made in raising awareness and reducing knowledge and capacity gaps, notably with respect to the values of biodiversity and ecosystem services (national target 1), IAS (national target 9), threatened species (national target 12) and the conservation and sustainable use of aquatic and marine resources (national target 6).

More specifically, the package of information compiled and made publicly available on the values of biodiversity and ecosystems services in Mauritius and Rodrigues shall:

- Support decisions on the basis of a consistent integration of multiple types of value (e.g. ecological, cultural and monetary) and associated valuation methods to inform decision making processes;
- Feed on different knowledge systems (e.g. scientific, traditional, professional);
- Rely on both qualitative and quantitative information;

- Cover values emerging at different levels of societal organisation, from individuals, to communities, to nations;
- Be useful in different public, private and community-based decision or policy making processes and applications, which requires such values to be expressed in a manner that complies with or respects the rules or principles governing those processes or applications.

4.3 Plan for resource mobilisation for NBSAP implementation

The development and implementation of a Resource Mobilisation Strategy has been made a priority activity for 2017 in both the MAP and RAP (national target 20). This strategy shall assess the baseline and alternative future scenarios regarding:

(1) International flows of financial resources to Mauritius and Rodrigues;

(2) Financial resources available for biodiversity in Mauritius and Rodrigues;

(3) Steps already taken and that need to be taken to fully implement the MAP and RAP.

The Strategy for Resource Mobilisation shall confirm the financial resources needed to implement the MAP and RAP and shall specify the activities (e.g. technical cooperation) and policy changes (e.g. green tax reform) required to mobilise them through all sources, including the domestic budget, external assistance (where relevant) and innovative financial mechanisms. Attention shall be given to double counting, which has the potential to artificially inflate any assessment of resource availability, as well as to efficiency in information collection so as to improve the RoM's reporting to the CBD on

(1) Data, in monetary units, on flows of financial resources for biodiversity from developed to developing countries;
(2) Data, in monetary units, on financial resources available for biodiversity;
(3) Information on the steps countries are taking to implement the strategy for resource mobilisation; and
(4) Information (both qualitative and quantitative, including in monetary terms) on the role of specific initiatives including those relating to technical cooperation, and innovative financing mechanism).

5 INSTITUTIONAL COORDINATION, MONITORING, EVALUATION AND REPORTING

5.1 National Coordination Structure and thematic/regional committees

This NBSAP has a 9-year duration (2017 – 2025) with a mid-term review planned for 2020. It is intended to be a living document so that stakeholders can propose, submit and approve additional projects for inclusion as part of the NBSAP activity portfolio. The National Focal Point (NFP) is the Permanent Secretary of the Ministry of Agro-Industry and Food Security (MAIFS). Cooperation between stakeholders is to be supported and strengthened for an equitable and transparent implementation of the NBSAP, notably through three working groups in Mauritius (i.e. Terrestrial Biodiversity Working Group, Agro-biodiversity Working Group and Freshwater, Coastal and Marine Working Group) and the Rodrigues Environment Committee in Rodrigues.

5.2 National Clearing-House Mechanism

The national CHM was re-developed in 2016 (http:chm.govmu.org) and will be used as a tool to synthesise, compile and share information about the NBSAP and associated topics in the RoM. With the logistical and resource support of the National Parks and Conservation Service, all stakeholders are invited to contribute to it so as to making it a living website where all information regarding biodiversity, its status, values, trends, threats, and the activities undertaken towards its conservation, sustainable use and / or restoration are made available (full versions, not just executive summaries), free-of-charge to all citizens and stakeholders worldwide.

5.3 Monitoring and Evaluation of the MAP and RAP

The strategy is intended to have a 9-year duration 2017-2025 with an independent review during year five (2020), which will provide the basis for a consultative revision of the NBSAP so as to enable an adaptive management approach and the optimal attainment of goals and objectives. Specific steps shall be taken to ensure that the implementation of the NBSAP of the RoM will be monitored and evaluated (national target 20, see sections 3.1.20 and 3.2.20):

- MAP implementation committee is sustainable (meeting every 3 months) involving all key stakeholders;
- RAP implementation committee is set up in 2017, within REC, and is sustainable (meeting every 3 months involving all key stakeholders);
- The focal point designates, on a full-time basis:
    - One responsible officer dedicated to coordinating and monitoring the MAP,
    - One responsible officer dedicated to coordinating and monitoring the RAP
- Each KPI of both the MAP and RAP is monitored on a quarterly basis;
- MoU are drafted and signed by the focal point and lead stakeholders responsible for implementing each MAP and RAP target;
- Annual status reports on Monitoring and Evaluation of the NBSAP prepared.

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Annex 1. List of stakeholders who contributed to the NBSAP at consultative workshops

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PART II

Preparatory Studies for NBSAP 2017 - 2025

REPUBLIC OF MAURITIUS

Ministry of Agro-Industry and Food Security

STUDY 1

Advances in cross-sectoral mainstreaming of biodiversity in Mauritius

May 2017

Recommended Citation

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Acronyms and Abbreviations

ACA	Additional Conservation Actions
ACTS	African Centre for Technology Studies
BBMP	Blue Bay Marine Park
BBOP	Business and Biodiversity Offsets Programme
CBD	Convention on Biological Diversity
CEPF	Critical Ecosystem Partnership Fund
CHM	Clearing-House Mechanism
CICES	Common International Classification of Ecosystem Goods and Services
CWA	Central Water Authority
DoE	Department of Environment
EEZ	Exclusive Economic Zone
EIA	Environmental impact assessment
ESA	Environmentally Sensitive Areas
FAD	Fish aggregating device
FAREI	Food and Agricultural Research and Extension Institute
FDI	foreign direct investment
FS	Forestry Service
GEF	Global Environment Facility
GoM	Government of Mauritius
IAS	Invasive Alien Species
IOC	Indian Ocean Commission
IPBES	Intergovernmental Platform for Biodiversity and Ecosystem Service
IUCN	International Union for Conservation of Nature
MA	Millennium Ecosystem Assessment
MAIF	Ministry of Agro-Industry and Fisheries (now MAIFS)
MAIFS	Ministry of Agro-Industry and Food Security
MARENA	Mauritius Renewable Energy Agency
MEPU	Ministry of Energy and Public Utilities
METT	Management Effectiveness Tracking Tool
MOEMRFS	Ministry of Ocean Economy, Marine Resources, Fisheries, and Shipping
MOEMRFSOI	Ministry of Ocean Economy, Marine Resources, Fisheries, Shipping and Outer Island (now MOEMRFS)
MOI	Mauritius Oceanography Institute
MPA	Marine Protected Area
MSSNSESD	Ministry of Social Security, National Solidarity and Environment and Sustainable Development
MSY	Mean sustainable yield
MT	Ministry of Tourism
NBSAP	National Biodiversity Strategy and Action Plan
NGO	Non-governmental organisation
NIASSAP	National Invasive Alien Species Strategy and Action Plan
NNL	No-Net-Loss
NPCS	National Parks and Conservation Service
NPI	Net Positive Impact
ODA	Overseas Development Assistance
PA	Protected Area
PAN	Protected Area Network
PANES	Protected Area Network Expansion Strategy

PGRU	Plant Genetic Resources Unit
PI	Predicted impact
PPG	Project Preparatory Grant (for GEF Projects)
RoM	Republic of Mauritius
RRA	Rodrigues Regional Assembly
SANBI	South African National Biodiversity Institute
SANPARKS	South African National Parks
SCBD	Secretariat of the Convention on Biological Diversity
SEMPA	South East Marine Protected Area
SIDS	Small Island Developing States
TEEB	The Economics of Ecosystems and Biodiversity
UNDP	United Nations Development Programme
UoM	University of Mauritius
VMCA	Voluntary Marine Conservation Area
VMCA	Voluntary Marine Conservation Area
WHS	World Heritage Site
WMA	Wastewater Management Authority
WRI	World Resources Institute
WRU	Water Resources Unit
GATT	General Agreement on Tariffs and Trade

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Executive Summary

This desktop study is an assessment of the biodiversity mainstreaming progress of the Republic of Mauritius (RoM) in line with the Convention on Biological Diversity (CBD) Strategic Plan 2011-2020 and its National Biodiversity Strategy and Action Plan (NBSAP). The study first focuses on identifying the interdependency links between biodiversity, ecosystem services and several sectors (agriculture, marine, tourism and water) and topics (land use management, food security and renewable energy). Stakeholder interests, potential partnerships and conflicts, as well as possible win-win scenarios are also explored. The study then discusses biodiversity conservation and mainstreaming efforts to date, highlighting key challenges and gaps and the main opportunities to seize. To that end, progress towards reaching the 20 CBD Aichi Targets was assessed and scored from excellent (3) to none (0). It appears that, despite some positive efforts for some Aichi Targets, weak progress (score of 1) was found for most. Given the highly-threatened biodiversity and seriously degraded natural capital stocks of the RoM, it is critical that all Mauritian stakeholders change their perspective from one focused on preserving the little that is left to one based on restoring (even creating) natural capital through new forms of development and innovation.

1 INTRODUCTION

1.1 Aims and scope of work

The main objective of this desktop study was to assess the mainstreaming elements of Mauritius' National Biodiversity Strategy and Action Plan (NBSAP), following the best international guidance and practice available on the matter to emphasize the role of biodiversity for long-term sustainability. The study focused on several sectors, agriculture, marine, tourism and water, and the following topics: land use management, food security and renewable energy.

1.2 Methodology and limitations

This study aimed to:

- Establish a link between the target sectors and topics targeted for biodiversity mainstreaming in the Mauritius NBSAP, with focus on threats to biodiversity and on benefits that biodiversity and ecosystem services can generate;
- Map in an analytical manner the relevant policies, interests of and stakes for target productive sectors and development agendas, and make recommendations for pro-biodiversity sustainable outcomes;
- Undertake a rapid assessment of the progress of the RoM in reaching the Aichi Targets as per the Convention on Biological Diversity (CBD) Strategic Plan for 2011 – 2020, by using a rating system to assess this progress (scoring of 0 to 3).

To that end, Dr. Joël Houdet (ACTS Team Leader), with logistical support from Mr. Daksh Beeharry Panray (NBSAP project manager) and technical support from Mr. Anand Sookun and Mrs. Poonam Tatayah (national consultants), has reviewed existing literature (policies, reports, academic papers) on the aforementioned topics. To gather such information, three stakeholder consultation workshops were organised on:

- May 24: Terrestrial Biodiversity Working Group;
- May 25: Agro-biodiversity Working Group;
- May 26: Marine, Coastal & Freshwater Biodiversity Working Group.

A project inception workshop help on May 27, 2016 was also instrumental to identify stakeholders, their perspectives and relevant sources of information (Figure 1.1).

The key findings and recommendations gathered from each working group were presented at the inception workshop. The overall UNDP NBSAP project background, progress to date and methodology for preparatory studies were also presented. The workshop included an intensive break-out session where each working group discussed in depth potential quantitative targets and associated performance / monitoring indicators in line with the Aichi Targets.

In addition, a round table involving sectoral representatives and development practitioners was organised in 15 December 2016 to:

- Discuss the results of the desktop study, including (a) threats to biodiversity deriving from economic activities and development policies and agendas and (b) benefits that biodiversity and ecosystem services can generate for these sectors;
- Identify partnerships between relevant stakeholders involved in biodiversity conservation issues and in development issues;
- Identify key stakeholders' interests, and desired outcomes in line with national priorities; and
- Identify potential conflicts and trade-offs, and work towards mutually acceptable solutions, including strategies that serve mutually beneficial interests and achieve mutually beneficial outcomes.

This report synthetises the results of the desktop assessment and the feedback received from stakeholders during the various consultation events.

Figure 1.1: Project Inception Workshop at the Sofitel Hotel, Flic-en-Flac

2 INTERDEPENDENCIES BETWEEN BIODIVERSITY AND THE ECONOMY IN THE ROM

2.1 Conceptual foundations

As explained by the Millennium Ecosystem Assessment (2005), inter-dependencies characterise the relationships between natural capital and our economy. On the one hand, people and companies depend on various ecosystem services for their living (e.g. clean water and foods) and / or doing business (e.g. raw materials) (Figure 2.1). On the other hand, their individual or collective activities can impact positively or negatively on the availability of such services to others, as well as on the condition and extent of the underlying natural capital stocks or assets. In fact, all organisations, whether private or public, depend upon and impact on natural capital to some degree and will experience risks and/or opportunities associated with those impacts and/or dependencies.

These aforementioned concepts, which underpin this study, are defined as follows:

Natural Capital: Natural capital is another term for the stock of renewable and non-renewable natural resources[1] on earth (e.g., plants, animals, air, water, soils, minerals) that combine to yield a flow of benefits or "services" to people (Natural Capital Protocol 2016). According to the Millennium Ecosystem Assessment (MA 2005), natural capital is one of four types of capital that also include manufactured capital (machines, tools, buildings, and infrastructure), human capital (mental and physical health, education, motivation and work skills) and social capital (stocks of social trust, norms and networks that people can draw upon to solve common problems and create social cohesion).

Ecosystem: An ecosystem is a community of living organisms (plants, animals and microbes) in interaction with the non-living (abiotic) components of their environment (air, water, soil) which constitutes a functioning system. Examples of ecosystems include deserts, coral reefs, wetlands or rainforests.

Biodiversity: The variability among living organisms on the earth, including the variability within and between species and within and between ecosystems. Biodiversity contributes to the formation and maintenance of natural capital (e.g. clean water and hydrocarbon formation) and hence the availability of ecosystem services for to the benefit of humans and organisations.

Ecosystem services: Ecosystem goods (material and energetic outputs) and services (non-material outputs) are defined here as the contributions that ecosystems make to human well-being, and arise from the interaction of biotic and abiotic processes. Following the Millennium Ecosystem Assessment, the term 'services' is generally taken to include both goods and services. According to the Common International Classification of Ecosystem

[1] As explained by the Natural Capital Protocol (2016), natural resources encompass a range of materials occurring in nature that can be used for production and/or consumption. **Renewable resources** may be exploited indefinitely, provided the rate of exploitation does not exceed the rate of replacement, allowing stocks to rebuild (assuming no other significant disturbances). Renewable resources exploited faster than they can renew themselves may effectively become non-renewable, such as when over-harvesting drives species extinct (UN 1997). **Non-renewable resources** will not regenerate after exploitation within any useful time period. Non-renewable resources are sub-divided into reusable (e.g. most metals) and non-reusable (e.g. thermal coal).

Goods and Services (CICES) (Haines-Young & Potschin, 2013), ecosystems services can be classified into three categories:

- Provisioning services: generate beneficial goods, such as food and water
- Regulating services: generate tangible benefits derived from ecosystem processes, such as flood and disease control.
- Cultural services: generate social benefits obtained from experiencing ecosystems, such as recreation and spiritual values.

Impacts: According to the Natural Capital Protocol (2016), a "natural capital impact is the negative[2] or positive[3] effect of business activity on natural capital. Natural capital impacts can arise directly from business operations or indirectly from the use of products and services. Impacts may occur at any point in the value chain, through exploration and extraction of raw materials, intermediate processing, the production of finished goods, distribution, consumption, disposal, or recycling. Natural capital impacts will also vary depending on the industrial sector concerned, the stage of the supply chain, and the geographic location of operations."

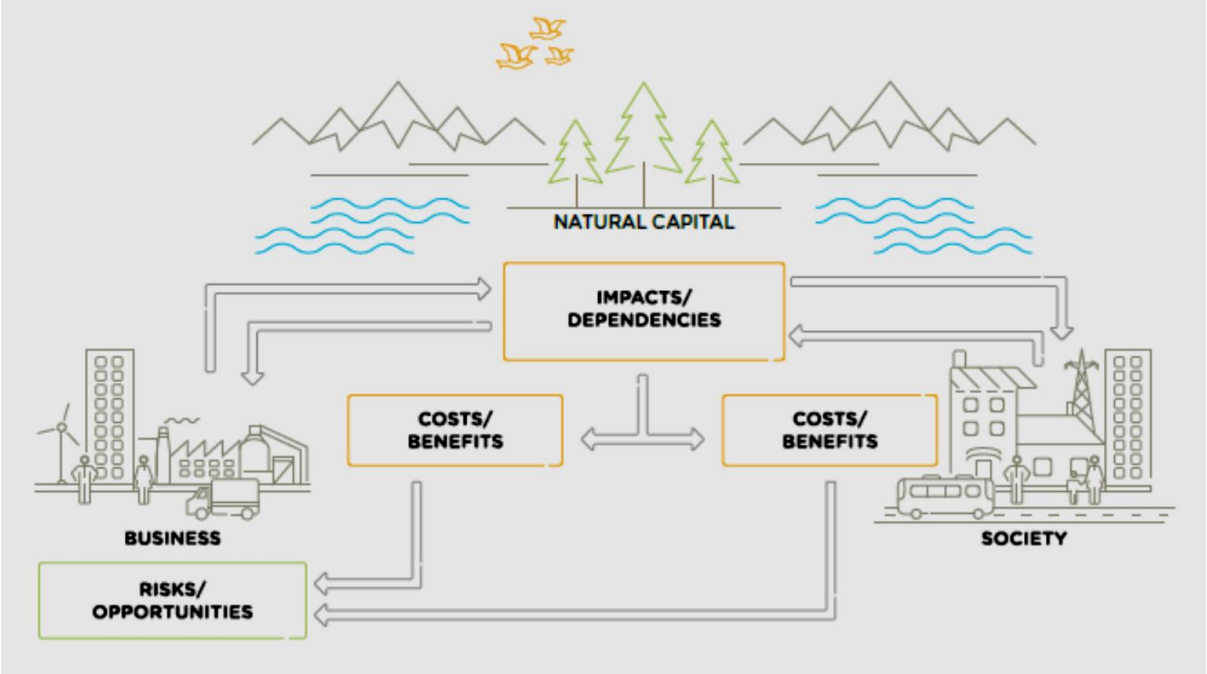


Figure 2.1: Conceptual model of interactions between business, society, and natural capital (Natural Capital Protocol 2016)

[2] An example of negative impact is the loss of biodiversity due to land use change / degradation or various forms of pollutions affecting the condition of natural capital stocks such as waterbodies.
[3] Examples of positive impacts include species recovery due to pro-active investments in restoration and offset measures, resulting in restored and new populations of the target species.

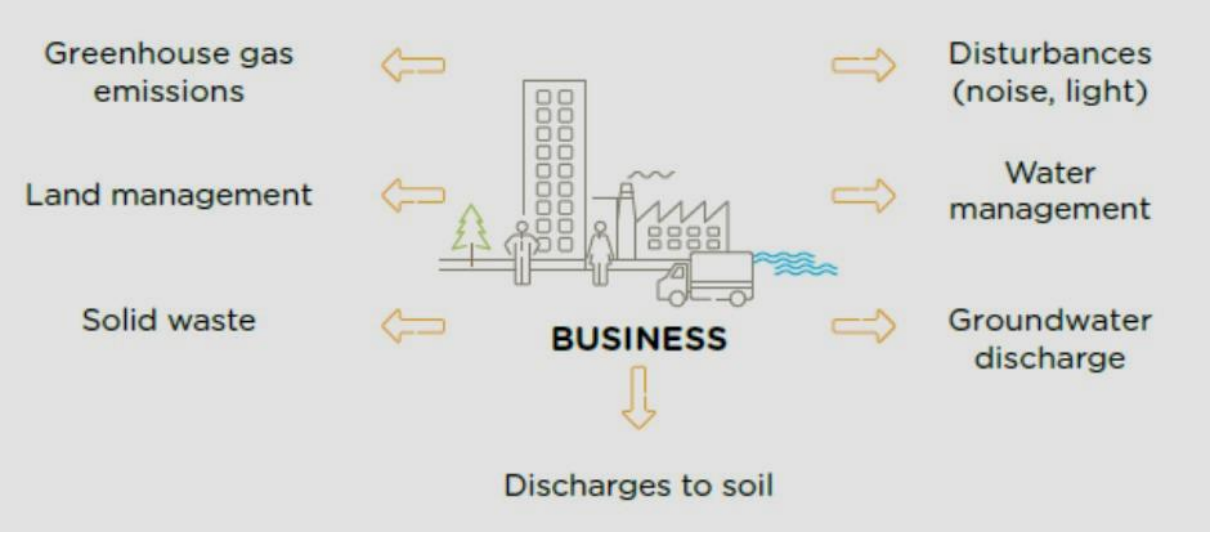


Figure 2.2: Examples of business impacts on natural capital (Natural Capital Protocol 2016).

2.2 Historical development pathways correlated to biodiversity loss

A development success story

The RoM is located in the Indian Ocean 800 km southeast of Madagascar. It consists of two main islands, Mauritius (1,865 km^2) and Rodrigues (109km^2) and two groups of outer islands, namely the St Brandon Archipelago (3 km^2) and Agalega (21 km^2). Mauritius gained its independence on the 12th March 1968 and became a Republic on the 12th March 1992. Mauritius is a stable, multiparty parliamentary democracy, and changing coalitions are a feature of politics in the country.

In 2015, the total population was 1.263 million with a growth rate of about 1.1% per year. Over the next 10 years' population growth is expected to stabilise at replacement levels or less, but as population density in Mauritius is already high at 600 people per km^2, the predicted modest population growth will increase pressures on land use. The country was ranked 63th on the Human Development Index in 2014, with life expectancy at birth of 74.4 years and an adult literacy rate of 89.2%.

Over the last three decades the Mauritian economy has been regarded as a success story, with annual growth rates of over 5 % for many years and a per capita income of US$ 19,480 in 2015 (World Bank data). The country is listed 15th in the 2016 Economic Freedom global ranking (1st in Sub-Saharan Africa)[4]. Mauritius is amongst the top group of upper middle-income countries and was ranked 46th in the Global Competitiveness Index 2015–2016, the first sub-Saharan African country.

Despite external headwinds, especially sluggish growth in the Euro Zone, on which Mauritius is highly dependent for tourism, trade and foreign direct investment (FDI), the economy grew by 3.5% in 2015, similar to the 3.4% pace in 2014. Growth continues to be supported by tourism, information and communications technology (ICT) and the financial and insurance sectors, which grew by 8.6%, 6.9% and 5.2%, respectively (World Bank data). In

[4] URL: http://www.heritage.org/index/country/mauritius

contrast, the construction sector shrank for a second consecutive year (by 4.3%) and textile value-added also declined by 1%.

According to the World Bank (2016), Mauritius's main socio-economic challenges include: increasing competitiveness through greater regional integration, creating a stronger environment for innovation, making growth more inclusive by addressing a scarcity of skilled human resources, and bolstering resilience to natural disasters and climate change.

Development at the expense of biodiversity

Mauritius and Rodrigues form part of the Western Indian Ocean Islands, part of one of the 25 internationally recognized biodiversity 'hotspots'. The tropical climate, topography and over ten million years of isolation have resulted in the evolution of a diverse biota with a high degree of endemism (Table 2.1). Unfortunately, the development pathway of the RoM is correlated to significant biodiversity loss, as illustrated by the number of species that have gone extinct since the islands were first settled (Table 2.1).

Table 2.1: Native and endemic terrestrial species diversity in selected groups in Mauritius (Mau) and Rodrigues (Rod), with respective total number of extinctions (percentages are given in brackets; Florens, 2013)

	Total Native		Total Endemic				Total Extinct				Endemic Extinct			
	Mau	Rod	Mau		Rod		Mau		Rod		Mau		Rod	
Angiosperms	691	150	273	(39.5%)	47	(31.3%)	61	(8.8%)	17	(11.3%)	30	(11.0%)	10	(21.3%)
Mammals	5	2	1	(20.0%)	0		2	(40.0%)	1	(50.0%)	0		0	
Land birds	28	14	19	(67.9%)	13	(92.9%)	16	(57.1%)	11	(78.6%)	12	(63.2%)	11	(84.6%)
Reptiles*	17	8	16	(94.1%)	8	100.0%)	5	(29.4%)	8	(100.0%)	5	(31.3%)	8	(100.0%)
Butterflies	30	10	5	(16.7%)	0		4	(13.3%)	1	(10.0%)	1	(20.0%)	0	
Snails	125	30	81	(64.8%)	16	(53.3%)	43	(34.4%)	7	(23.3%)	36	44.4%)	5	(31.3%)

*One species of gecko survives on Rodrigues but it was first recorded after 1884 and is believed to be cryptogenic.

Before its discovery by the Portuguese in 1507, Mauritius supported a rich biodiversity, and is now sadly famous as the former home of the flightless Dodo (*Raphus cucullatus*), the very symbol of species extinction. There were no terrestrial mammalian predators in pre-settlement Mauritius, which allowed the evolution of a number of flightless birds and large reptile species. The arrival of man saw extensive habitat loss and degradation and the introduction of invasive alien species (IAS). Over 100 species of plants and animals have become extinct since settlement and many more are threatened. The Dutch East India Company first began to clear forest to exploit the ebony and palms in the lowlands, a process which was accelerated markedly during the later French and the British administrations to make room for agriculture, roads and settlements. The cleared forest areas were planted with sugar cane, tea, eucalyptus and pine. Today, less than 2% of the native forest that once stretched from the mountain tops of the central plateau to the shore now remains, concentrated in the Black River Gorges National Park in the south west, the Bambou Mountain Range in the south-east and the Moka-Port Louis Range in the North West.

Coastal and marine ecosystems, though in better condition than terrestrial ones, are under severe threats from both marine and land-based activities, including agriculture, industry and urbanisation. Coral reefs and sea grass beds are being damaged by coastal development, sedimentation, marine pollution, anchor damage and pollution from inland activities. Though expanded tourism activities have provided considerable direct and indirect employment, these have also led to the rapid construction of hotels and other facilities along the shoreline, leading to habitat losses and increasing disturbances on coastal and marine ecosystems. For instance, backfilling of wetlands for construction is affecting 90 % of all wetlands and resulting in a reduction in the area under natural habitats. A comparison of the wetland area in Grand Baie over time revealed an estimated 23% decrease from 2000 to 2008 due to backfilling and increased urbanisation, exacerbating flooding (RoM 2011).

In other words, terrestrial, freshwater, coastal and marine ecosystems are under ongoing pressures, including from exotic invasive species, climate change, habitat degradation, pollution and excessive resource extraction (MAIFS 2015a). This presents considerable conservation and restoration challenges for the country.

2.3 Sectoral and thematic analysis

This section presents a comparative analysis of the links between target sectors (agriculture, marine, tourism and water) and topics (land use management, food security and renewable energy) and biodiversity and ecosystem services. To that end, several criteria were used: dependencies on biodiversity and ecosystem services, impacts on biodiversity and ecosystem services, risks and opportunities. The results are summarised in Tables 2.2 and 2.3.

The section also aims to:

- Identify key stakeholders' interests, and desired outcomes in line with national priorities;
- Identify partnerships between relevant stakeholders involved in biodiversity conservation issues and in development issues;
- Identify potential conflicts and trade-offs, and work towards mutually acceptable solutions, including strategies that serve mutually beneficial interests and achieve mutually beneficial outcomes.

Table 2.2: Comparative analysis of target sectors regarding ecosystem dependencies, impacts, risks and opportunities

Biodiversity and ecosystem services					
		Dependencies	Impacts	Risks	Opportunities
Sectors	Agriculture	Medium to high for provisioning (genetic resources of crops, freshwater, soils) and regulating services (erosion, water quality and climate regulation, pollination, nutrient assimilation, and pest control).	Mostly negative, especially through native vegetation clearance, unsustainable resource use (freshwater, soils) and pollution (nutrient emissions in water systems, greenhouse gases, herbicides and pesticides).	Increased input costs and decreases in productivity due to loss of soils (quality and quantity) and over-exploitation of freshwater resources (including aquifers).	New environmentally friendly agricultural systems, provided there is sufficient support (human capacity, financial resources) to help farmers to transition to sustainable practices.
	Marine	Medium to high for provisioning (seafoods - fish, shellfish, algae, etc., seawater, seabed substrates) and regulating services (erosion, water quality and climate regulation, wastewater treatment/nutrient assimilation).	Mostly negative, especially through unsustainable resource use (seafoods) and marine-based pollution (waste from ships). Also, fishing pressure, increase in tourism related sea-based activities. Marine environment also affected by land-based activities through pollution and run-off.	Increased capital and labour costs associated with decreases in productivity (for fishing scarcer resources). Beach and lagoon space decreases.	New environmentally friendly fishing methods and governance systems, provided there is sufficient support (human capacity, financial resources) to help industry players to transition to sustainable practices. Proper zoning of lagoons for different sea-based activities needed
	Tourism	Medium to high for provisioning (water, foods, ornamental artefacts), regulating (climate and water system regulation) and cultural services (recreational activities such as big game fishing, swimming and scuba diving).	Mostly negative, especially through unsustainable resource use (overfishing recreational species) and both land and marine-based pollution (waste from hotels and tourist boats).	Decreases in tourist numbers due to lower attractiveness (polluted waters, and degraded habitats such as coral reefs)	New environmentally friendly tourism practices, from catch and release fishing to minimum / zero- waste hotels and eco-tourism ventures.
	Water	High for provisioning (freshwater - quantity and quality) and regulating services (erosion, water quality and climate regulation, wastewater treatment/nutrient assimilation by plants and micro- organisms).	Mostly negative via excessive water abstraction from rivers and ground water resources and the conversion ("artificialisation") of rivers and wetlands.	Increased capital and labour costs due to the loss of groundwater resources (i.e. increased costs of access) and of the capacity of freshwater systems to supply regulation services (i.e. increased water treatment costs). This will impact all economic sectors and human communities that depend on water resources.	Investment in ecological infrastructure (rivers, wetlands, forests) to restore the capacity of natural capital stocks to store, clean and provide freshwater.

Table 2.3: Comparative analysis of target topics regarding ecosystem dependencies, impacts, risks and opportunities

Biodiversity and ecosystem services					
		Dependencies	**Impacts**	**Risks**	**Opportunities**
TOPICS	**Land use management**	Varies according to the type of land use. Artificial land uses tend to depend on a limited number of ecosystem services (e.g. focus on provisioning services for agricultural lands, focus on climate regulation and freshwater supply for housing) while protected areas usually rely on a greater diversity of services, from provisioning (water, genetic re- sources) to regulation (e.g. soil formation, water and climate regulation, erosion control, biotic regulations of pests and diseases) and cultural services (e.g. hiking, birdwatching).	Varies according to the type of land use. Artificial land uses have the most negative impacts (e.g. housing, industries, monocultures) while (well managed) wild and protected have positive impacts on the renewal of natural capital stocks and associated flows to people.	Unsustainable land use management, for both artificial and wild/protected areas, can lead to the loss of natural capital stock and their capacity to supply services to people and businesses.	Improved land use management is possible for all types of land uses and should aim to minimise/reduce provisioning service consumption (e.g. water, crops, seafoods) and restore the functional capacities of natural capital stocks for the sustainable delivery of ecosystem services to all Mauritians.
	Food security	Similar to agricultural sector in general (see Table 2.2), but greater reliance on a diversity of genetic resources.	Similar to agricultural sector in general (see Table 2.2), with negative impacts due to natural vegetation clearance, unsustainable resource use and pollution.	Continued reliance on a limited number of foreign crops/cultivars. Loss of local crops and wild relatives.	Focus on the development of new cultivars / crops based on local genetic resources. Diversification of crops for local consumption and agricultural systems (e.g. agroforestry).
	Renewable energy	Varies according to the type of renewable energy: freshwater for hydroelectricity, bio-waste for biogas, wave, tides, current and thermal energy for marine renewable energy, wind for wind turbines, sun's rays for solar energy, etc.	Positive impacts on climate regulation services. Negative impacts vary, from large footprints (hydroelectricity), habitat change (marine renewable energy infrastructures) to animal kills (wind turbines). Biogas plants have very limited impacts (apart from residues when not used for other productive purposes).	Social acceptability of renewable energy plants may decrease. In some cases, changes in ecosystem services supply may affect operations.	Renewable energy plants can be well integrated in the landscape, with minimal footprints and biodiversity impacts, besides the inherent climate benefits (i.e. significantly lower greenhouse gas emissions throughout their life-cycle compared to oil and coal-based energy production).

The agricultural sector

Agriculture in Mauritius has always been broadly categorised into two main groups: sugar and non-sugar (i.e. vegetables, fruit, ornamentals, medicinal plants and livestock) farming. Today, 46% of Mauritius Island is under agricultural cultivation, of which 82% is sugar cane. Mauritius is usually self-sufficient in fresh vegetables but not for fruits, and imports some potatoes, onions, garlic and maize as well as all of its wheat and rice (MAIFS 2015a). There is some export of tropical fruits, notably litchis and pineapples. Mauritius is self-sufficient in venison, pork, chicken meat and eggs although 80% of the ingredients for feed is imported. Most other meat is imported -for example 90% of beef and 40% of goat meat consumed comes from abroad.

While agriculture relies on various provisioning (e.g. freshwater, soils, crop and animal genetic resources) and regulating (e.g. nutrient, climate, water cycle and erosion regulation, pollination, pest control) ecosystem services (Table 2.2), the sector is directly linked to historical biodiversity loss as crops and animals have been introduced since the first settlements in the seventeenth century. These impacts have thus been largely negative:

- Native vegetation clearance and habitat degradation to create new agro-ecosystems for food production;
- Unsustainable resource use (surface and ground water resources, soils);
- Pollution: e.g. nutrient emissions in water systems via fertilisers, greenhouse gases, herbicides and pesticides (kills non-target species, such as pollinators and pest predators).

The continuing loss and degradation of ecosystem services presents serious risks for the agricultural sector. Increasing input costs associated with decreasing productivity is a real risk, typically due to the loss of soils (quantity and quality) and overexploitation of freshwater resources (including aquifers). The opportunities lie in pro-actively exploring and promoting environmentally friendly agricultural systems and practices, which would need to include a mix of measures including minimising inputs / pesticides / herbicides, no more native vegetation clearance and investments in the restoration of ecological infrastructure (including soil biodiversity and freshwater systems, typically by creating diverse agro-systems based on multi-cropping – e.g. agro-forestry systems). Helping farmers to transition to sustainable practices would be a prerequisite. This would require significant human and financial resources. The key stakeholders, their interests, potential partnerships and conflicts, as well as potential win-win scenarios for this sector are presented in Table 2.4.

Table 2.4: High level analysis of potential stakeholder dynamics for the agriculture sector

Key stakeholders	Main interests	Likely partnerships	Potential conflict with	Win-win opportunities
National government (MAIFS)	Food Security, production volumes, jobs, sustainability.	Development agencies, farmers, private sector clients.	Conservation/environmental NGOs, farmers (over the laws and regulations, compliance monitoring and enforcement).	Strong stakeholder participation in rules / standard definitions, compliance monitoring and enforcement design and implementation.
Conservation/environmental NGOs	Chemicals, pesticides, water and soil conservation, pollinators, local breeds and varieties, sustainable/green/organic practices.	Development agencies, some farmers, private sector clients.	Farmers, national government (MAIFS) (weak environmental standards/rules, lack of compliance enforcement, insufficient human and financial resources).	Strong environmental standards with significant commitments for effective ecological transition.
Farmers	Revenue, productivity.	National government (MAIFS), Conservation/environmental NGOs.	Conservation / environmental NGOs, national government (MAIFS) (rules and standards too strict, lack of support to cover opportunity costs of ecological transition).	True opportunity costs compensated, training, focus on market development, strong policies (subsidies) to support ecological transition.
Consumers	Quality, price.	Private sector clients (food retailers, hotels), Conservation/environmental NGOs, farmers.	Farmers (price and quality of more ecological products)	Increased costs covered (at least partially) by subsidy schemes, strong education campaigns about the benefits of environ-mentally friendly and organic foods (despite less attractive appearance).
Private sector clients (food retailers, hotels)	Costs, quality volumes.	Farmers, national government (MAIFS), development agencies		
Development agencies	Productivity, environmental, economic and social sustainability.	National government (MAIFS), farmers, Conservation/environmental NGOs (project development and implementation).	National government (MAIFS), private sector clients (food retailers, hotels) (scope of activities, rules of engagement, performance monitoring).	Clear project goals, activities, milestones, performance indicators, monitoring system and feedback loop mechanisms.

The marine sector

The coastline of Mauritius is 322 km long and almost entirely surrounded by a fringing coral reef enclosing a lagoon area totalling 243 km^2. The coral reef of St Brandon covers an area of 190 km^2, while that of Agalega covers 100 km^2. Mauritius' EEZ covers over 2.3 million km^2 (including 396 km^2 which is co-managed with the Seychelles) of which 99 % is still unexplored and under researched. The marine sector depends on various provisioning and regulating ecosystem services (Table 2.2).

First, marine natural capital stocks are very diverse. According to Mauremootoo *et al*. (2003), much of the marine biodiversity found in Mauritian waters consists of common Indo Pacific species that constitutes common biota for biotopes such as sea grass beds, coral reef, mangroves, sandy, muddy and rocky shores. For instance, there are four types of reef around Mauritius: fringing reefs, patch reefs, atolls and barrier reefs, with the Mauritian offshore islands of the St. Brandon archipelago including a group of 22 atolls. The condition of these habitats or other natural capital stocks are associated with various ecosystem processes which supply regulating services (e.g. erosion, water quality and climate regulation, wastewater treatment / nutrient assimilation) (Table 2.2).

Secondly, the economic and social importance of provisioning services of coastal and marine ecosystems is now widely recognised (RoM 2013, Sultan 2012) (Table 2.2). Out of 340 species of fish identified in the waters of Mauritius, 41 are of economic importance within the inshore area, with a different composition and relative abundance in the near-shore waters of each island within the RoM. Several species of crabs, shrimps, lobsters, molluscs, octopus and sea cucumbers are also of commercial value. A recent DNA based assessment of commercial fish diversity of Mauritius by the Mauritius Oceanography Institute (MOI) has shown the number of commercial fish species to be 186, out of which 41 are new records to Mauritius and 3 may be potentially new species (RoM, 2015).

Fishery resources have been traditionally exploited in lagoons and offshore areas around Mauritius. There are four main types of fisheries in Mauritius, namely artisanal fisheries, sport fisheries, banks fisheries and tuna fisheries. Artisanal fishing provides employment and livelihood to some 2,200 fishermen and their families. Main families of fish that are caught are Lethrinids, Siganids, Mullets, Scarids and Groupers. The banks fishery consisting of mainly Lethrinids (90%) catches around 3,000 tonnes annually. The tuna fishery is split into the Fish Aggregation Devices (FADs) and the offshore industrial tuna fishery. Tuna and tuna-like species are caught by local fishermen off-lagoon and around FADs. The total landings from FADs and sport fishermen are estimated at around 650 tonnes annually. Species caught are big eye tuna, skipjack, yellow fin tuna, dorado, wahoo and sharks. Industrial tuna fishing is carried out mainly by long-liners and purse-seiners mostly licensed foreign fishing vessels that catch about 10,000 tonnes yearly in the EEZ of Mauritius. The species caught are mainly the skipjack tuna and yellow fin tunas. Other fisheries resources include the deep-water shrimp with an estimated Mean Sustainable Yield (MSY) of 200 tonnes per year.

There have been many impacts on marine natural capital stocks and associated provisioning and regulating services (Table 2.3). Total fish catch has declined from 19,690 tonnes in 1993 to 5,270 tonnes in 2011 (RoM 2013). Reef and demersal fish stocks are over-exploited and no substantial increase in fish production in these areas is expected in future. The effect of over-fishing of Lethrinids is apparent on the fringing reefs of Mauritius with a population explosion of sea urchins *Diadema* sp. and *Echinometra* sp.

The majority of octopi, particularly females, are being caught before they reach maturity, which takes place when they reach 700-800g. Gleaning for crabs in the lagoon is a popular pastime, but there are no data on the effect that this has on the populations of targeted species such as *Portunus* (Swimming Crabs) and *Grapsu*s crabs. Despite regulations, over-exploitation has resulted in falling populations of several species, including spiny lobsters (MAIF 2005). Large quantities of these animals are now being imported from Madagascar because of continuing demand and dwindling local supplies.

To summarise, coastal and marine ecosystems, though in better condition than terrestrial ones, are under severe threats from both marine (Table 2.3) and land-based activities, including agriculture, industry and urbanisation. Coral reefs and sea grass beds are being damaged by coastal development, sedimentation, marine pollution, anchor damage and pollution from inland activities. This effectively means that all industries relying on marine resources are threatened. Increased capital and labour costs will be linked to decreases in productivity (i.e. for fishing scarcer resources) (Table 2.3). Intense pressure from sea and land based activities threatens to prevent the full socio-economic potential of the country from being realised, as well as the long-term goal of creating a sustainable ocean economy (RoM 2013).

Though the potential for aquaculture is estimated to be 29,000 tonnes of fish per year in the medium term and about 39,000 tonnes of fish per year in the long term, the environmental impacts of such activities (e.g. water pollution, genetic pollution of wild stocks, introduction of potentially invasive species) cannot be discounted. This is not the solution. New environmentally friendly fishing methods and governance systems need to be proactively explored and mainstreamed in all fisheries. Helping industry players to transition to sustainable practices will require:

- Significant improvements in marine ecosystem governance;
- Significant investments in capacity building for cost-effective ecosystem assessment, monitoring, protection and rule enforcement as well as in environmentally friendly fishing and shipping techniques and practices (i.e. to cover opportunity costs for fishermen and shipping companies);

Political will and courage to foster change in individual perceptions and value systems given current destructive fishing practices.

The key stakeholders, their interests, potential partnerships and conflicts, as well as potential win-win scenarios for the marine sector are presented in Table 2.5.

Table 2.5: High level analysis of potential stakeholder dynamics for the marine sector

Key stakeholders	Main interests	Likely partnerships	Potential conflict with	Win-win opportunities
National government (MOEMRFS)	Tax revenue, production volumes, jobs, sustainability. Licensing fees, fishing activities & fisheries resource exploitation.	Development agencies, fishermen, shipping companies, private sector clients. Also, foreign fishing vessel companies.	Conservation/environmental NGOs, fishermen and shipping companies (over the laws and regulations, compliance monitoring and enforcement).	Strong stakeholder participation in rules /standard definitions, compliance monitoring and enforcement design and implementation.
Conservation / environmental NGOs	Water pollution, sedimentation, habitat degradation, biodiversity conservation, coral reefs, marine mammals, sustainable fisheries.	Development agencies, some fishermen, private sector clients (hotels).	Fishermen, national government (MOEMRFS) (weak environmental standards/rules, lack of compliance enforcement, insufficient human and financial resources).	Strong environmental standards with significant commitments for effective ecological transition.
Fishermen Shipping companies	revenue, productivity.	National government (MOEMRFS), Conservation / environmental NGOs.	Conservation/environmental NGOs, national government (MOEMRFS) (rules and standards too strict, lack of support to cover opportunity costs of ecological transition).	True opportunity costs compensated, training, focus on market development, strong policies (subsidies) to support ecological transition.
Consumers	Quality, price.	Private sector clients (food retailers, hotels), Conservation/environmental NGOs, fishermen.	Fishermen (price and quality of more ecological products).	Increased costs covered (at least partially) by subsidy schemes, strong education campaigns about the benefits of environmentally friendly and organic foods (despite their sometimes less attractive appearance).
Private sector clients (food retailers, hotels)	Costs, volumes, quality.	Fishermen, national government (MOEMRFS), development agencies.		
Development agencies	Productivity, environmental, economic and social sustainability.	National government (MOEMRFS), fishermen, shipping companies, Conservation / environmental NGOs (project development and implementation).	National government (MOEMRFS), private sector clients (food retailers, hotels) (scope of activities, rules of engagement, performance monitoring).	Clear project goals, activities, milestones, performance indicators, monitoring system and feedback loop mechanisms.

The tourism sector

Tourism is the third pillar of the Mauritian economy after manufacturing and agriculture. It contributes significantly to economic growth and has been a key factor in the overall development of Mauritius (RoM 2014). Gross earnings from tourism were Rs 44,304 million in 2014, with 1,038,968 tourist arrivals recorded, with France (23.5%), Réunion (13.6%) and United Kingdom (11.1%) the principal markets (RoM, 2014). There were 112 hotels with a total room capacity of 12,799 and a bed capacity of 26,174. Total room and total bed occupancy rates of all hotels were 65% and 58% respectively. Tourism may be called to play an even more important role in the wake of the post-GATT Agreements.

Tourism activities in Mauritius depend on many ecosystem services:

- Provisioning services such as water, foods and ornamental artefacts (e.g. flowers, sea shells);
- Regulating services such as climate (e.g. tourists seek ideal weather conditions) and water system regulation; and
- Cultural services linked to recreational activities, from big game fishing, sunbathing, swimming to scuba diving (i.e. the primary attractions of the country for tourists).

Expanded tourism activities have provided considerable direct and indirect employment, which have led to the rapid construction of hotels and other facilities along the shoreline, leading to habitat losses and increasing disturbances on coastal and marine ecosystems. For instance, backfilling of wetlands for construction is affecting 90 % of all wetlands and resulting in a surface reduction of natural habitats. A comparison of wetland area in Grand Baie over time revealed an estimated 23% decrease from 2000 to 2008 due to backfilling and increased urbanisation, exacerbating flooding (RoM 2011).

Decreases in the number of tourists due to lower attractiveness (polluted sea, degraded coral reefs) of Mauritius is a real risk in an increasingly competitive tourism market and sluggish global growth (Lallchand 2013). Opportunities exist in new environmentally friendly tourism practices, and several other countries have already taken the lead on such approaches, notably the Seychelles and the Galapagos Islands (Ecuador) where tourism products are directly linked to environmental stewardship. Avenues to focus on should include:

- Improving existing hotel practices, towards minimal footprints (water, greenhouse gases) and waste (reuse and recycling practices);
- Catch and release recreational fishing, ecological / clean boating and permanent ecological moorings;

Only allowing new investments based on strong ecotourism principles, where significant amounts are spent on ecological restoration (e.g. building on the work done at Ile aux Aigrettes) so that net gains in biodiversity and ecosystem services are achieved.

The key stakeholders, their interests, potential partnerships and conflicts, as well as potential win-win scenarios for the tourism sector are presented in Table 2.6.

Table 2.6: High level analysis of potential stakeholder dynamics for the tourism sector

Key stakeholders	Main interests	Likely partnerships	Potential conflict with	Win-win opportunities
National government (MT, MOEMRFS, FS, NPCS)	Tourism growth, up market and selective tourism policy, sustainable practices, new eco-tourism products (FS, NPCS).	Tourism operators, hotels, shops and restaurants, development agencies, conservation/environmental NGOs.	Conservation/environmental NGOs (over policies and regulations), tourism operators (marketing issues), hotels, shops and restaurants (product offerings).	Strong stakeholder participation in rules / standard definitions, compliance monitoring and enforcement design and implementation, strong support (subsidies, marketing) for new product development.
Conservation/environmental NGOs	Water. pollution, habitat degradation, eco-tourism.	National government (MT, MOEMRFS, FS, NPCS), tourists, tourism operators, hotels, development agencies.	Tourism operators, hotels, shops and restaurants (lack of effort and commitment, greenwashing).	Strong financial support for new eco-tourism products, strong environmental standards with significant commitments for effective ecological transition.
Tourism operators	Revenue, product offerings and attractiveness, quality of tourism products.	National government (MT, MOEMRFS, FS, NPCS), tourists, hotels, development agencies.	National government (Ministry of Tourism and External Communications, MOEMRFS, FS, NPCS), hotels, NGOs (lack of attractive new green products).	Significant investments in environmental stewardship of existing tourism operations and development of world class eco-tourism products.
Hotels, shops and restaurants	Revenue, sales, costs, quality.	National government (MT, MOEMRFS, FS, NPCS), conservation/environmental NGOs.	National government (MT, MOEMRFS, FS, NPCS), conservation/environmental NGOs.	Support (subsidies) to cover the costs of changes in practices.
Tourists	Product quality, price, new experiences	Tourism operators, hotels, shops and restaurants, conservation / environmental NGOs.	Tourism operators, hotels, shops and restaurants (product offerings do not satisfy their needs anymore, too much greenwashing).	Significant investments in environmental stewardship of existing tourism operations and development of world class eco-tourism products, better marketing.
Development agencies	Sustainable tourism practices.	National government (MT, MOEMRFS, FS, NPCS), tourism operators, hotels, NGOs.	National government (MT, MOEMRFS, FS, NPCS) (scope of activities, rules of engagement, performance monitoring).	Clear project goals, activities, milestones, performance indicators, monitoring system and feedback loop mechanisms.

The water sector

The fresh water supply of Mauritius consists of 92 rivers, 11 man-made lakes, 2 natural lakes, and groundwater distributed into 5 main aquifers. The mean annual rainfall varies from 750 mm on the coast to 4200 mm on the Central Plateau. Surface water is diverted into 25 major and 21 minor basins and is utilised for domestic and industrial purposes and to service the heavy irrigation needs of sugar cane plantations. A number of wells have been drilled, mostly for irrigation and domestic use.

Obviously, the water sector depends on surface and groundwater provisioning services. In 2004, annual water utilisation was about 1030 Mm^3, equivalent to approximately 26% of the Island's average annual rainfall[5]. About 882 Mm3 were from surface water and the remaining 148 Mm^3 from groundwater which accounts for 57% of municipal water supply (domestic, industrial, tourism). Water is mainly used for the following purposes: domestic, industrial and commercial (~ 21%); industrial (private boreholes) (~1%); agricultural (~48%) and hydropower (~30%). About 99.4 % of the population has access to safe water.

The water sector also depends heavily on regulating services (erosion, water quality and climate regulation, wastewater treatment / nutrient assimilation by plants and micro-organisms) which have been impaired due to the widespread clearance and degradation of freshwater systems and associated forested catchments. While groundwater is only chlorinated prior to being channelled into the distribution system, surface raw water is treated at six water treatment plants having a total treatment capacity of 248,000 m^3/day. Service delivery is effected through a 3,500 km distribution network. 105 service reservoirs with storage capacity of 238,000 m^3 sustain the supply.

There are many risks facing the water sector, driven largely by an increase in demand by industries and tourists. Meeting the water requirements of the different sectors up to the year 2040 will lead to increased water extraction, treatment and distribution costs. The projections for potable water requirements assume a population of 1.6 million and a per capita consumption 250 litres/day in 2040. The current population is 1.2 million and the per capita consumption is 190 litres/day.

The issues of water quality are closely tied up with the management of the catchment areas, the coastal zone and fisheries. Any wastewater discharged into the rivers inevitably ends up in the lagoon while deforestation on the steep slopes in the central region erodes topsoil and causes siltation of the river basins, ultimately ending up in the coastal zone. The main negative impacts of economic activities on water resources include:

- Industrial and non-point source pollution;
- Wastewater disposal;
- Pesticide and herbicide use;
- Agricultural chemicals and haphazard disposal of waste;

[5] URL : http://www.un.org/esa/agenda21/natlinfo/countr/mauritiu/WATERmauritius04f.pdf

– Algal growth and invasive plants.

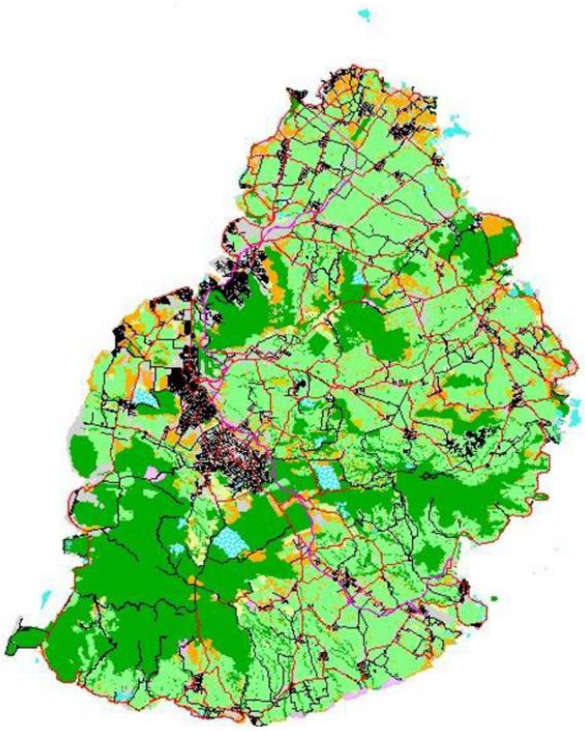
Careful planning and effective water conservation measures are needed. Opportunities to maximise the delivery of both water provisioning and regulating ecosystem services (wastewater treatment / water cycle regulation – i.e. storing, cleaning and realising slowly storm water) lie in re-orienting the water sector towards investing in the restoration of ecological infrastructure (wetlands, rivers, forest catchments). Key stakeholders, their interests, potential partnerships and conflicts, and potential win-win scenarios for the water sector are outlined below.

Table 2.7: High level analysis of potential stakeholder dynamics for the water sector

Key stakeholders	Main interests	Likely partnerships	Potential conflict with	Win-win opportunities
National government (MEPU, CWA; WMA, WRU)	Water extraction, treatment & distribution, capital investments, operational costs.	National government (FS, NPCS), industries, fishermen, development agencies.	Industries, households, fishermen, NGOs (water allocation and pricing, wastewater treatment rules for point source pollution, non-point source pollution).	Strong, continuous stakeholder participation in rules / standard definitions, compliance monitoring and enforcement design and implementation, transparency, educational campaigns.
National government (FS, NPCS)	Forest catchments, river reserves.	National government (MEPU, CWA; WMA, NGOs.	NGOs (forest catchment management policies and restoration progress).	Financing of ecological integrity restoration secured via partnerships with water users (payment for ecosystem services).
Conservation/environmental NGOs	Water conservation, ecological infrastructure, soils, forest catchments.	National government (FS, NPCS, MEPU, CWA, WMA), farmers, industries, households.	Industries, households, national government (wastewater, water allocation and pricing, water resources management).	Strong political support for integrated catchment to sea ecological infrastructure / ecosystem restoration approach, fair water allocation system, ambitious and effective water conservation measures via performance based contractual agreements with all water users.
Industries	Wastewater treatment costs.	National government (MEPU, CWA; WMA), FS, NPCS), development agencies.	National government (MEPU, CWA, WMA) (wastewater regulations and costs, water supply, quality and price), fishermen (conflicts over water access during droughts).	Sufficient human and financial support for ecological transition (i.e. wastewater treatment measures), educational campaigns on the benefits of investing in ecological infrastructure upstream.
Households	Water quality, price.	National government (MEPU, CWA, WMA), NGOs.		Strong educational campaigns to explain water saving measures and the need to finance water conservation measures upstream (increased tariffs).
Fishermen	Water availability, costs.	National government (FS, NPCS, (MEPU, CWA; WMA), NGOs.	NGOs (limited efforts, lack of commitment), industries and households (conflicts over water access and price).	Sufficient human and financial support for ecological transition, including water conservation measures, ecological infrastructure restoration and new greener products.
Development agencies	Safe, clean water supply to all, water conservation.	National government, industries, NGOs.	National government (scope of activities, rules of engagement, performance monitoring).	Clear project goals, activities, milestones, performance indicators, monitoring system and feedback loop mechanisms.

Land use management

Today, agriculture is the primary land use in Mauritius (41.5% in 2011; Figure 2.3) and land is largely privately owned. Vacant land for development is limited since most of the useable land has already been put to productive use. Of a total land area of 186,500 ha, 77,418 ha is devoted to agriculture, 68,946 ha to forests or green areas and the remaining areas are either built upon or unusable.



LEGEND	MAJOR LAND USE	AREA (ha) & %
Sugar cane Other crops Livestock production	Agriculture	77,418 (41.5%)
Abandoned sugar cane land		1,468 (0.8%)
Reserves (Mountain & River) Waste land Rock heap Leisure (beach, public garden, etc.)	Forest, Shrub, Range & Grazing Land	68,946 (37.0%)
Water body & marsh/ inland water resources		2,719 (1.5%)
Built-up area		28,070 (15.1%)
Highway Main road Secondary road/parking	Infrastructure	78,79 (4.2%)
Total area (ha)		**186,500 (100.0%)**

Figure 2.3: Land use in Mauritius (Source: Chung Tze Cheong *et al.*, 2011)

Dependence on ecosystem services varies according to the type of land use. Artificial land uses tend to depend on a limited number of ecosystem services (e.g. focus on provisioning services for agricultural lands, focus on climate regulation and freshwater supply for housing) while protected areas rely usually on a greater diversity of services, from provisioning (water, genetic resources) to regulation (e.g. soil formation, water and climate regulation, erosion control, biotic regulations of pests and diseases) and cultural services (e.g. hiking, birdwatching).

Impacts on ecosystem services also vary according to the type of land use. Artificial land uses have the most negative impacts (e.g. housing, industries, monocultures) while (well managed) wild and protected areas have positive impacts on the renewable of natural capital stocks and associated flows to people.

Land use management can lead to further, unnecessary loss of natural capital stocks and their capacity to supply services to people and businesses. Improved land use management is also possible for all types of land uses:

- For productive and artificial land uses, it should aim to minimise / reduce provisioning service consumption (e.g. water, crops, seafood) and restore the functional capacities of natural capital stocks (e.g. ecological

infrastructure such as rivers, wetlands, soils and their associated biota) for the sustainable delivery of ecosystem services to all Mauritians.

- For wild, semi-natural and protected areas (e.g. mangroves, dunes, coral reefs), the focus should be on their effective management towards ecological integrity, including the control (and where possible eradication) of invasive alien species and the restoration of habitat complexity for maximum ecosystem services supply and delivery to surrounding land uses and associated beneficiaries.

Furthermore, one should mention the concept of ecosystem-based disaster risk reduction[6] in the context of land use management. Ecosystem-based disaster risk reduction is defined as the sustainable management, conservation and restoration of ecosystems to reduce disaster risk. It aims to achieve sustainable and resilient development. Well-managed ecosystems, such as wetlands, forests and coastal systems, act as natural infrastructure, reducing physical exposure to many hazards and increasing socio-economic resilience of people and communities by sustaining local livelihoods and providing essential natural resources such as food, water and building materials. Ecosystem management also generates a range of other social, economic and environmental benefits for multiple stakeholders, which in turn feed back into reduced risk.

The key stakeholders, their interests, potential partnerships and conflicts, as well as potential win-win scenarios for land use management are presented in Table 2.8.

[6] https://www.iucn.org/commissions/commission-ecosystem-management/our-work/cems-thematic-groups/eco-disaster-risk, accessed December 19, 2016.

Table 2.8: High level analysis of potential stakeholder dynamics for land use management

Key stakeholders	Main interests	Likely partnerships	Potential conflict with	Win-win opportunities
National government (MSSNSESD)	Compliance with regulations, stakeholder management.	Industries, farmers, NGOs.	Land owners and leaseholders.	Strong stakeholder participation in rules / standards definitions, compliance monitoring and enforcement design and implementation.
Protected Area Network stakeholders (FS, NPCS, private nature reserves), MHL, Local Authorities and MAIFS	Protected Area Network expansion, improving PA performance management, ecological integrity restoration, invasive species control /eradication.	NGOs development agencies.	Land owners and leaseholders who do not want to participate in the Protected Area Network, farmers adjacent to river reserves and other protected areas.	Innovative financing mechanisms to support protected area expansion and environmental stewardship.
Conservation/environmental NGOs	Environmental stewardship for all productive land uses, effective protected area network, protection of environmental sensitive areas.	Protected Area Network stakeholders (FS, NPCS, private landowners), development agencies.	Industries and farmers (complaints about pollution).	
Industries	Cost minimisation (environmental regulations), land availability for development.	National government (MSSNSESD).	National government (MSSNSESD) (pollution crisis and penalties), NGOs (complaints).	Innovative financing mechanisms to support good practice waste water management.
Households	Aesthetics (gardens) and recreation, land price/availability.	NGOs, national Government.	Industries, farmers (air and water quality).	Strong educational campaign to explain ecological gardening.
Farmers	Land productivity and availability.	National government (MSSNSESD, FS, NPCS).		Innovative financing mechanisms to support environmental stewardship (restoration of ecological infrastructure).
Development agencies	Sustainable land management for all land uses.	National government, industries, NGOs, farmers.	National government (scope of activities, rules of engagement, performance monitoring).	Clear project goals, activities, milestones, performance indicators, monitoring system and feedback loop mechanisms.

Food security

The Mauritian economy was predominantly agricultural and based on sugar cane production until the 1970s. In other words, the economy relied on provisioning services. Since the 1980s, there has been an increase in industrialisation and economic diversification. The agricultural sector's contribution to GDP has declined from 23% in 1970 to 6.2% in 2004 with sugar cane, tea and tobacco contributing 66% of this total, food crops 20%, and livestock and poultry 10%.

Many of the current crops grown and animals reared have been selected and evolved for decades, if not centuries, in the local agro-ecosystems, hence generating local varieties and breeds which now constitute the agricultural biodiversity of Mauritius:

The native flora has a species that is regularly exploited (*Dictyosperma album* var. *album*) and three members of one genus (*Coffea* spp.) that has yielded economically important crops elsewhere:

- Two of these *Coffea* species (*Coffea macrocarpa* and *C. myrtifolia*) are endemic to Mauritius, while the third, C*. mauritiana*, is also found in Réunion. These species are naturally caffeine-free and could be of great importance in developing low caffeine cultivars (Dulloo 1998).
- The endemic palmiste blanc (*Dictyosperma album* var. *album*) is cultivated in plantations for its palm cabbage. This local trade is estimated to be worth Rs. 20 m per year (Govinden 2004). In the past the cabbages were exported, but the trade has stopped as local demand from hotels and restaurants is greater than the supply.

Although they are not native, several wild relatives of important crops have become naturalised in Mauritius:

- These include tomato (*Lycopersicon esculentum* var. *tallerell*i), pigeon pea (*Cajanus cajan*), potato (*Solanum commersonii*), *Solanum torvum* (white flowers) and *Solanum indicum* (violet flowers).
- An interesting species, Lentille Créole (*Vigna glabrescens*), is believed to be unique. It was found in the Pamplemousses Garden and is extensively used in the development of fusarium-wilt resistant beans. Seeds are stored in the Vigna collection at Gembloux, Université Agricole, Belgium.
- In Rodrigues, native grass species can still be found in pasture (e.g. *Cynodon dactylon* - Chiendent, *Paspalum commersonii* - Herbe à epée, *Stenotaphrum dimidiatum* – Herbe Bourrique), although species introduced accidentally and deliberately, for erosion control, now dominate.

However, in addition to climate change (water availability issues), there is an ever-increasing reliance on introduced higher yielding crop varieties and animal breeds, which is a major risk for food security, including lost future opportunities based on local breeds, crops and wild relatives. For instance, local breeds of cow, pig, goat, sheep and poultry used to exist in Rodrigues, but high levels of outcrossing with introduced breeds make it difficult to find the pure local forms anymore. This progressive loss of genetic resources is ongoing, for instance when Government field stations with important genetic resources are released for commercial production.

While Mauritius ratified the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits in 2013, the country has a lot of lesser known and under-utilised crops to which value needs to be added and their utilisation encouraged (Gurib-Fakim 2005). Promoting local breeds and varieties, typically through new niche markets targeting local businesses, especially in the tourism sector, should be a priority. It is therefore imperative that a comprehensive characterisation of all local cultivars and varieties of crops, fruit, vegetables and breeds of livestock there are in Mauritius should be undertaken (MAIFS 2016). The key stakeholders, their interests, potential partnerships and conflicts, as well as potential win-win scenarios for food security are presented in Table 2.9.

Table 2.9: High level analysis of potential stakeholder dynamics for food security

Key stakeholders	Main interests	Likely partnerships	Potential conflict with	Win-win opportunities
National government (MAIFS)	Food security, tax revenue, volume of production, jobs, sustainability.	Development agencies, farmers, private sector clients	Conservation/environmental NGOs, farmers (over varieties and breeds promoted).	Strong stakeholder participation in planning/policy design, promotion of local breeds and varieties (diversification).
Conservation environmental NGOs	Local breeds and varieties, water and soil conservation, pollinators, sustainable/green/organic practices.		Farmers, National government (MAIFS) (weak environmental standards/rules, lack of compliance enforcement, insufficient human and financial resources)	Strong environmental standards (water and soil conservation), significant human and financial support for the conservation and sustainable use of local crops, wild relatives and breeds.
Farmers	Revenue, productivity, secure markets.	National government (MAIFS), conservation/environmental NGOs.	Conservation/environmental NGOs, National government (MAIFS) (rules and standards too strict, lack of support to cover opportunity costs of diversification).	True opportunity costs compensated, training, focus on market development, strong policies (subsidies) to support crop and breed diversification.
Consumers	Quality, price, healthy and ecological products.	Private sector clients (food retailers, hotels), Conservation/environmental NGOs, farmers.	Farmers (price and quality of new products).	Research and development costs covered (at least partially) by subsidy schemes, strong education campaigns about the benefits of food diversification based on local varieties and breeds.
Private sector clients (food retailers, hotels)	Costs, quality volumes.	Farmers, national Government (MAIFS), development agencies.	Farmers (price and quality of new products).	
Development agencies	Genetic resources conservation, environmental, economic and social sustainability.	National government (MAIFS), farmers, Conservation/environmental NGOs (project development and implementation).	National government (MAIFS), private sector clients (food retailers, hotels) (scope of activities, rules of engagement, performance monitoring).	Clear project goals, activities, milestones, performance indicators, monitoring system and feed-back loop mechanisms.

Renewable energy

Mauritius has no known oil, natural gas or coal reserves, and therefore depends on imported petroleum products to meet most of its energy requirements. Local renewable energy sources are biomass, hydro, solar, marine and wind energy. Biomass energy consists mainly of bagasse, a by-product of the sugar industry, and contributes about 22 % of the primary energy supply (MEPU)[7]. Fuel wood and charcoal are hardly used. Hydropower plants, with a combined installed capacity of 59 MW, represents virtually the entire hydro potential. Mauritius has a good solar regime with a potential average annual solar radiation value of some 6 kWh/m^2/day. The wind regime in Mauritius is very good in some areas, with an annual average speed of 8.1 m/s at 30 m above ground level.

Dependence on ecosystem services vary according to the type of renewable energy: freshwater for hydroelectricity; bio-waste for biogas; wave, tides, current and thermal energy for marine renewable energy; wind for wind turbines; the sun's rays for solar energy, etc. However, apart from biogas, all of these are abiotic services. Similarly, impacts on biodiversity and ecosystem services vary according to the type of renewable energy. While positive impacts on climate regulation services are generated by all renewable energy sources, negative impacts vary from large footprints / habitat loss (hydroelectricity), habitat change (marine renewable energy infrastructures) to animal kills (wind turbines). Biogas plants have very limited impacts (apart from residues when not used for other productive purposes).

While changes in ecosystem services supply (e.g. water for hydropower) may affect operations, the real challenge lies in the social acceptability of renewable energy plants. In some cases, local communities are concerned about visual impacts (e.g. wind turbines) while other technologies have negative impacts as previously discussed. However, because their inherent climate benefits (i.e. significantly lower greenhouse gas emissions throughout their life-cycle compared to oil and coal-based energy production), renewable energy plants should be encouraged and mainstreamed by all stakeholders, within the context of the RoM's Intended Nationally Determined Contribution to the UNFCCC (RoM 2015). Great care should be taken to integrate renewable energy projects well in the landscape, with minimal footprints and biodiversity impacts (e.g. agrofuels and biofuels are problematic, with many environmental shortcomings; Campbell & Doswald, 2009). This is the only way to ensure their acceptance by all stakeholders.

The key stakeholders, their interests, potential partnerships and conflicts, as well as potential win-win scenarios for renewable energy are presented in Table 2.10.

[7] HTTP: http://publicutilities.govmu.org/English/Pages/Publications.aspx

Table 2.10: High level analysis of potential stakeholder dynamics for renewable energy

Key stakeholders	Main interests	Likely partnerships	Potential conflict with	Win-win opportunities
National government (Ministry of Energy and Public Utilities, Mauritius Renewable Energy Agency (MARENA)	Energy security, capital and operational expenditures, market regulation, promotion of new energy sources, climate change mitigation and adaptation.	Renewable energy project developers, financial sector, development agencies.	Conservation/environmental NGOs, local communities (project location and associated biodiversity impacts).	Strong, inclusive stakeholder participation in project planning and development, avoidance of environmentally sensitive areas.
Industries	Low energy costs, secure supply.	National government (MEPU, MARENA), renewable energy project developers, development agencies.	Conservation/environmental NGOs, local communities (project location and associated biodiversity impacts).	
Renewable energy project developers	Return on investment, electricity/energy price, supportive policy environment.	National government (MEPU, MARENA), development agencies.	Conservation/environmental NGOs, local communities (project location and associated biodiversity impacts).	
Conservation/environmental NGOs	Low carbon energy, low impact project development.	Local communities, development agencies.	Renewable energy project developers, financial sector, MARENA (project location and associated aesthetical / environmental impacts).	
Financial sector	Return on investment, supportive policy environment.	Renewable energy project developers, national government (MEPU, MARENA), development agencies.	Conservation/environmental NGOs (project location and associated biodiversity impacts).	
Local communities	Low energy costs, secure supply, climate change.	Conservation/environmental NGOs.	Renewable energy project developers, financial sector, MARENA (project location and associated aesthetical/environmental impacts).	
Development agencies	Project financing, climate change mitigation and adaptation.	Renewable energy project developers, national government (MEPU, MARENA).	Conservation/environmental NGOs (project location and associated biodiversity impacts).	

3 BIODIVERSITY MAINSTREAMING PROGRESS IN THE REPUBLIC OF MAURITIUS

3.1 Policy context

The Mauritius NBSAP 2006 – 2015 was prepared in order to meet the country's obligations under the Convention on Biological Diversity (Article 6a) and provide a strategic approach for biodiversity management in Mauritius for the coming decade (2006 –2015). This document did not incorporate the Aichi Targets set out in 2011. However, Mauritius' biodiversity strategic objectives and programmes of work are in line with the 2020 Aichi Targets for Target 5, Targets 6, Targets 7, Targets 8, Targets 9, Targets 10, Targets 11, Targets 12, Targets 13, and partially in line with Targets 14, Targets 18 and Targets 19 (RoM 2015).

This section summarises biodiversity conservation and mainstreaming efforts to date, highlighting key challenges and gaps and the main opportunities to seize. This analysis makes use of the findings of the Mauritius Fifth National Report (MAIFS 2015a), the 2016 NBSAP stakeholder consultation processes and two other preparatory studies (i.e. valuation of the Mare Longue and Mare-aux-Vacoas catchments – MAIFS 2017a - and an ecosystem-based adaptation study for the Protected Area Network – MAIFS 2017b) undertaken by ACTS as part Project ID 00087316 (Award id: 00075390 - National Biodiversity Planning to Support the Implementation of the CBD 2011-2020 Strategic Plan in Mauritius).

3.2 Review of the Aichi Targets and implications for the NBSAP

The Aichi Targets of the CBD are structured on five strategic goals:

- Strategic Goal A: Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society;
- Strategic Goal B: Reduce the direct pressures on biodiversity and promote sustainable use;
- Strategic Goal C: To improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity;
- Strategic Goal D: Enhance the benefits to all from biodiversity and ecosystem services;
- Strategic Goal E: Enhance implementation through participatory planning, knowledge management and capacity building.

Individual targets for each strategic goal are listed as follows.

Strategic Goal A : Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society

Target 1: By 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.

Target 2: By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.

Target 3: By 2020, at the latest, incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed in order to minimise or avoid negative impacts, and positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the Convention and other relevant international obligations, taking into account national socio economic conditions.

Target 4: By 2020, at the latest, Governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits.

Strategic Goal B: Reduce the direct pressures on biodiversity and promote sustainable use

Target 5: By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.

Target 6: By 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits.

Target 7: By 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.

Target 8: By 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity.

Target 9: By 2020, invasive alien species and pathways are identified and prioritised, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.

Target 10: By 2015, the multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimised, so as to maintain their integrity and functioning.

Strategic Goal C: To improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity

Target 11: By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area- based conservation measures, and integrated into the wider landscapes and seascapes

Target 12: By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.

Target 13: By 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity.

Strategic Goal D: Enhance the benefits to all from biodiversity and ecosystem services

Target 14: By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.

Target 15: By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.

Target 16: By 2015, the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization is in force and operational, consistent with national legislation.

Strategic Goal E: Enhance implementation through participatory planning, knowledge management and capacity building

Target 17: By 2015 each Party has developed, adopted as a policy instrument, and has commenced implementing an effective, participatory and updated national biodiversity strategy and action plan.

Target 18: By 2020, the traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels.

Target 19: By 2020, knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.

Target 20: By 2020, at the latest, the mobilisation of financial resources for effectively implementing the Strategic Plan for Biodiversity 2011-2020 from all sources, and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilisation, should increase substantially from the current levels. This target will be subject to changes contingent to resource needs assessments to be developed and reported by

Stakeholder consultations in May 2016 highlighted the challenges and barriers in reaching these ambitious Aichi Targets by 2020 in Mauritius. These barriers to effective biodiversity conservation and mainstreaming are common to many SIDS, which all tend to have historically focused on activities linked to Strategic Goal C "To improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity" (i.e. very little work on other strategic objectives). This calls for realistic, practical targets to be adopted by all stakeholders so that tangible positive changes in biodiversity condition and trends can be achieved.

3.3 Scoring methodology

A simple scoring methodology was chosen given the desktop nature of this study. Based on literature review and stakeholder consultations, progress towards reaching each Aichi Target was scored as follows: excellent (4), good (3), average (2), weak (1), none (0).

3.4 Progress towards Strategic Goal A: Awareness of biodiversity values and their integration into sectoral strategies, planning, accounting and reporting processes

Table 3.1 summarises the mainstreaming scores (i.e. progress towards reaching each Aichi Target) for the Aichi Targets of Strategic Goal A in Mauritius. More detailed explanations of each score is provided in sections 3.4.1 (Aichi Target 1), 3.4.2 (Aichi Target 2), 3.4.3 (Aichi Target 3) and 3.4.4 (Aichi Target 4).

Table 3.1: Progress towards reaching Aichi Targets of Strategic Goal A in Mauritius

Strategic Goal	Aichi Target	Score	Short explanation
Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society.	1. By 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.	1	General awareness of importance of some ecosystem services, very limited understanding of values (a couple of limited studies). As a result, very limited understanding of steps that need to be undertaken.
	2. By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.	1	Environmentally Sensitive Areas have been identified but limited integration in land use planning, experimental ecosystem accounts for the country (no mainstreaming yet).
	3. By 2020, at the latest, incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed in order to minimise or avoid negative impacts, and positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the Convention and other relevant international obligations, taking into account national socio economic conditions.	0	No study / assessment undertaken to date.
	4. By 2020, at the latest, Governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits.	1	Several activities undertaken in diverse sectors to produce or consume in a more environmentally friendly manner, but concept of safe ecological limits not appropriate to Mauritius. The extent of ecosystem degradation requires thinking in terms of investing in ecological restoration and targeting no-net-loss and (ideally) net gains in biodiversity values.

3.4.1. Awareness of biodiversity values

Aichi Target 1 states that "*by 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably*." Mauritius' society is very diverse. It is apparent that, most of the stakeholders consulted as part of the NBSAP revision process, were aware of the critical ecosystem services made available by natural and transformed ecosystems. Common examples given by participants or included in project documents include:

- Natural freshwater wetlands which provide many ecosystem services that benefit both people and wildlife such as shelter for a wide diversity of animal and plant species, water storage, flood control, sediment and nutrient retention, carbon sink, shoreline stabilization; and aesthetic and educational values.

- Marine ecosystems which provide many recreational (tourism-related) and provisioning (e.g. numerous resources exploited) services.
- Natural and planted forests which reduce soil erosion, filter, store and gradually release water, sequester carbon, provide habitats for numerous species, and offer recreation / ecotourism opportunities are now widely recognised.

However, there is widespread belief among stakeholders met, who have a direct stake in ecosystem management or biodiversity conservation, that most Mauritians, including key policy and decision makers, have a very limited understanding of the full set of values that can be attached to biodiversity and that the latter has very limited direct links with their daily lives. Consequently, it is a fair assumption to make that few people have a clear, practical understanding of the steps they can take to conserve biodiversity values and use them sustainably. Though one can suppose these views are reasonably accurate, such perceptions have yet to be confirmed though proper population and specific stakeholder group (e.g. farmers, tourism industry, fishery industry) surveys.

The development of targeted capacity building and training programmes for each main stakeholder groups (i.e. school children and university students, private sector – tourism, agriculture, public sector, etc.) should build on the methodological approaches developed by the Intergovernmental Platform for Biodiversity and Ecosystem Services (2015) (IPBES) amongst those of others (Millennium Ecosystem Assessment - MA, The Economics of Ecosystem Services and Biodiversity - TEEB), initiatives which have all supported a pluralistic framework for ecosystem services valuation.

A prerequisite for such an approach would be an adequate, if not comprehensive, understanding and monitoring of the diverse values of biodiversity in Mauritius and Rodrigues. This is far from the case as only a couple of studies have attempted to value biodiversity and ecosystem services in Mauritius and Rodrigues[8]. For instance, Sultan (2012) undertook an economic valuation of the marine and coastal ecosystem on approximately 16 km of coastline of the main island of Mauritius. The value of ecosystem services was estimated at Rs 210m annually, 18% linked to the fisheries sector while the remaining was attributed to non-use, existence and option value values (including some recreational benefits).

The RoM and interested stakeholders should thus develop a comprehensive biodiversity valuation and value monitoring framework and strategy for Mauritius and Rodrigues. To that end, Figure 3.1 illustrates the chapters of the IPBES (2015) guide regarding the diverse conceptualisation of multiple values of nature and its benefits, including biodiversity as well as ecosystem functions and services. Each chapter of this guide recognises the

[8] As part of this project "National Biodiversity Planning to Support the Implementation of the CBD 2011-2020 Strategic Plan in Mauritius", a preparatory study "Ecosystem valuation of catchment from Mare Longue / Mare aux Vacoas to downstream users" (MAIFS 2017a) was undertaken.

existence of different worldviews which determine the way value and foci of value might be addressed, associated valuation methodologies and approaches, and the data sources and data types that can be used in valuation studies and assessments of such studies. It is important to note that the choice of any particular worldview can be associated with various types of value and relate to all the foci of value. The six steps proposed by the IPBES protocol for valuation and assessment processes is presented in Figure 3.2, highlighting the importance of the application or purpose of the valuation to define the scope and appropriate valuation methods.

As argued by Gómez-Baggethun *et al*. 2014, for more than a decade, the literature on ecosystem services valuation has stressed the importance of integrating social, ecological, and monetary aspects of the values of ecosystem services and biodiversity in environmental decision making[9], rather than using on a monistic approach dominated by a single worldview (Figure 3.3). Integrated valuation typically involves an interdisciplinary effort comprising multiple expert domains from both the social and the natural sciences. Interdisciplinarity, transdisciplinarity, and methodological pluralism are key elements in integrated ecosystem services valuation: "*The process of synthesizing relevant sources of knowledge and information to elicit the various ways in which people conceptualise and appraise ecosystems services values, resulting in different valuation frames that are the basis for informed deliberation, agreement and decision*" Gómez-Baggethun *et al*. 2014.

In other words, an integrative biodiversity valuation framework for Mauritius and Rodrigues should:

- Support decisions on the basis of a consistent integration of multiple types of value (e.g. ecological, cultural and monetary) and associated valuation methods (Figure 3.4) to inform decision making processes;
- Feed on different knowledge systems (e.g. scientific, traditional, professional);
- Rely on both qualitative and quantitative information;
- Cover values emerging at different levels of societal organization, from individuals, to communities, to nations;
- Be able to accommodate different valuation rationalities[10];
- Be useful in different public, private and community-based decision or policy making processes and applications, which requires such values to be expressed in a manner that complies with or respects the rules or principles governing those processes or applications (Houdet and Chikozho, 2015).

[9] In that context, it is worth remembering that valuation refers to the understanding of the worth or importance of something and may be defined as "the act of assessing, appraising or measuring value, as value attribution, or as framing valuation" (Dendoncker et al., 2013).

[10]Social processes of valuation, either monetary or non-monetary, are value articulating institutions, i.e. constructed set of rules that not only reveal values, but also contribute to shape and construct them in the valuation process itself. Valuation methods and associated rationalities are frames invoked in the process of expressing values that regulate and influence which values come forward, which are excluded, and what sort of conclusions can be reached (Gómez-Baggethun *et al*. 2014).

Figure 3.1: Chapters of the IPBES (2015) guide on the diverse conceptualisation of multiple values of nature.

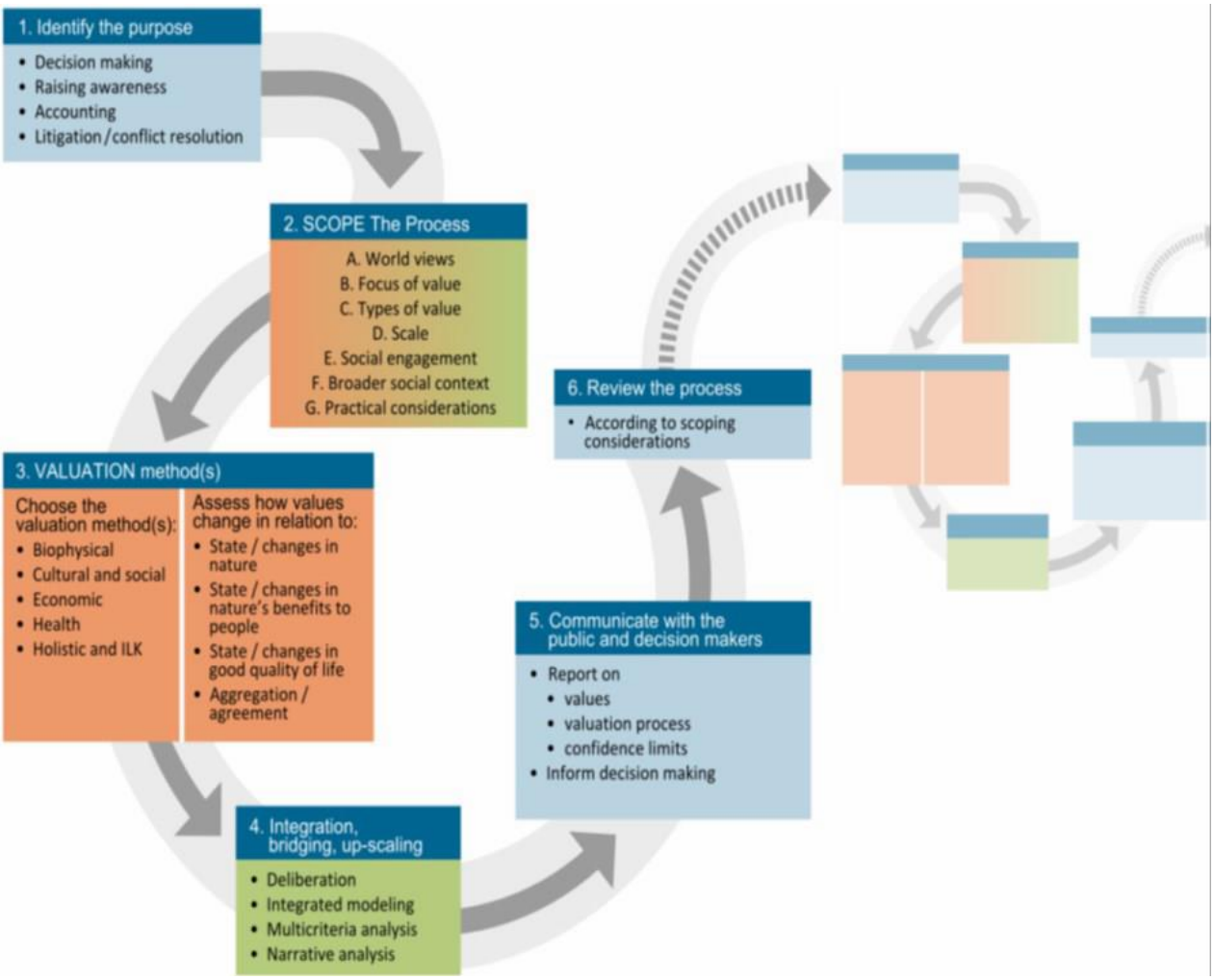


Figure 3.2: Illustration of the proposed six steps protocol for valuation and assessment processes (IPBES 2015)

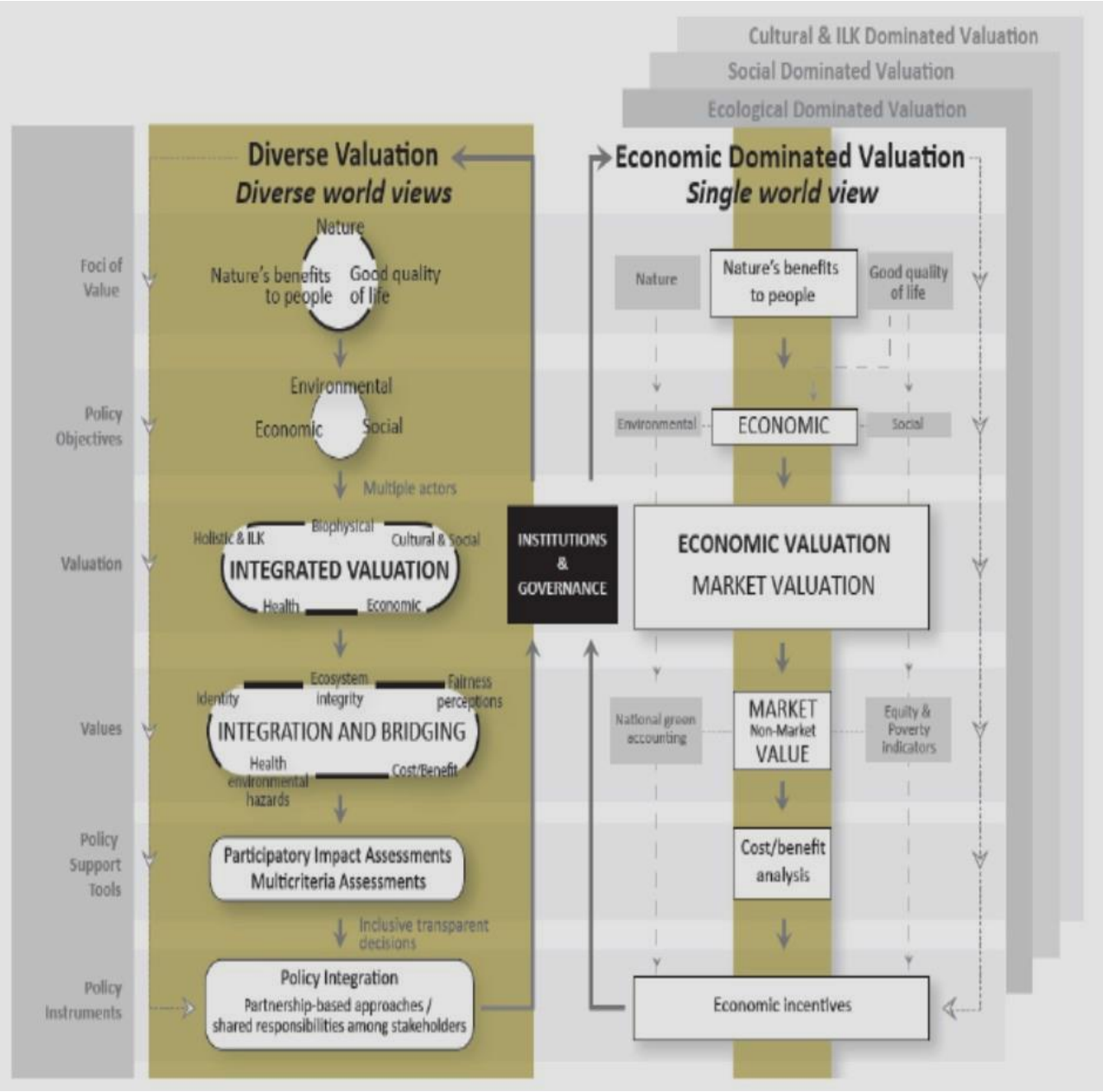


Figure 3.3: A stylised illustrative framework of contrasting approaches to the process of valuation of nature, nature's benefits to people and good quality of life. (IPBES 2015)

NB: The left side panel emphasises the importance of a pluralistic notion of value, compared with monistic approaches to human-nature relationships represented in the right-side panel. Monistic approaches dominated by a single worldview might overemphasise (i) the needs of ILK (Cultural & ILK dominated valuation), (ii) social development and poverty alleviation (Social dominated valuation), (ii) the conservation of biodiversity (Ecological/biophysical dominated valuation), or (iv) economic growth (Economic dominated valuation).

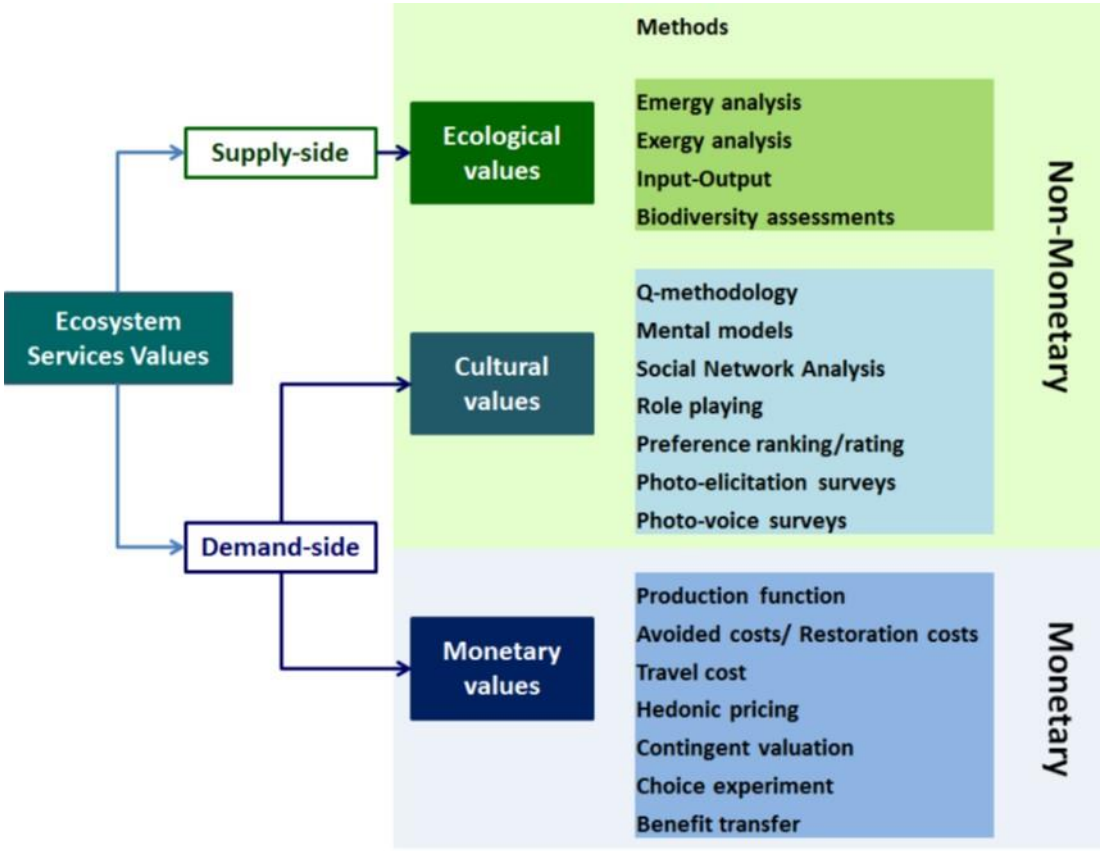


Figure 3.4: Methodological toolbox for an integrated valuation of ecosystem services which considers non-monetary and monetary valuation methods and the value-pluralism (Gómez-Baggethun *et al*. 2014)
Lack of knowledge on biodiversity values prevent their integration in sectoral strategies, planning, accounting and reporting processes.

3.4.2. Integration of biodiversity values

Aichi Target 2 states that "*by 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.*" To date, there is limited indication of any meaningful progress on this indicator though some efforts have been made:

- The Environmentally Sensitive Areas Study (RoM 2009a), making use of both quantitative (maps) and qualitative (sensitiveness rating) values, is being used by some stakeholders to identify biodiversity rich areas for planning and development project approval purposes (though this does not fully prevent habitat destruction yet);
- In 2012, the Indian Ocean Commission (IOC) supported the development of several Ecosystem/Natural Capital accounts (i.e. land use change, ecosystem water, ecosystem biomass-carbon, ecosystem integrity – biodiversity, ecosystem capability).
- Yet, it remains unclear whether these accounts are being used by any stakeholder, and whether there are any plans for further testing / standardising the methodologies used for regular use in national accounting / statistical practices.

Accordingly, there is a need to develop a comprehensive strategy and action plan to achieve this target, including:

- Assessing and monitoring the values of biodiversity and ecosystem services throughout the marine and terrestrial ecosystems of the RoM;
- Identifying practical means for integrating these in both public and private[11] policies, decision-making processes, strategies, planning processes, accounting and reporting systems;
- Identifying and quantifying the skills, human and financial resource needs.

3.4.3. Incentives harmful to biodiversity

Aichi Target 3 states that, "*by 2020, at the latest, incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed in order to minimise or avoid negative impacts, and positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the Convention and other relevant international obligations, taking into account national socio economic conditions*."

Though very little is currently known about existing incentives (including subsidies) in the RoM, as no study has been identified to date, it can be expected that certain industries and sectors (e.g. tourism, agriculture, construction, infrastructure, fisheries), with acknowledged negative impacts on biodiversity, are being supported by various government policies, strategies and incentives (e.g. see Bagnoli 2003). The only examples mentioned by stakeholders are the Bad Weather Allowances on days on which fishermen are unable to go fishing because of sea conditions and the failed attempt to reduce fishing pressure through seine-net licence buying back schemes (e.g. Hardman *et al*., 2014), which effectively reinforced the financial position of remaining fishermen (i.e. subsidised those who did not sell all their nets and continued fishing).

Accordingly, there is a need to undertake a full assessment of national and local government policies, strategies and incentives in Mauritius and Rodrigues, investigating their direct and indirect impacts on biodiversity and ecosystem services.

3.4.4. Investing in ecological restoration and targeting no-net-loss and (ideally) net gains in biodiversity values

Aichi Target 4 states that, "*by 2020, at the latest, Governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits*". This target is a particularly challenging one for several reasons:

[11] Private sector sustainability and environmental accounting and reporting is at its infancy in Mauritius, with some carbon / GHG and water assessments undertaken and mostly management approach based disclosures in annual reports (i.e. sustainability and integrated reports lack quantified data on impacts and pressures on biodiversity and ecosystem services).

- The safe ecological limits for most natural resource have not been precisely measured and quantified (e.g. resources overexploited or depleted decades ago, lack of research, lack of human capacity), apart from selected species (e.g. some fisheries);
- Many sectors import resources from overseas so that their impacts are located throughout their supply chains (e.g. importations of wood and feed for poultry industry);
- Many ecosystems in Mauritius and Rodrigues have been so severely transformed and degraded that thinking in terms of safe ecological limits is no longer appropriate. The focus should be on recreating resilient ecosystems and their capacity to supply a wide variety of ecosystem services. The principle of achieving no net loss and (ideally) net gains of biodiversity values should thus be promoted in all sectors and development projects.

Furthermore, stakeholders need to recognise that governments, businesses and human communities both impact and depend on biodiversity and ecosystem services (Natural Capital Coalition 2014; WRI 2012). While managing impacts typically involves impact avoidance, minimisation, rehabilitation / restoration and / or offset measures, the same approach can be applied to managing dependencies on ecosystem services. For instance, managing the water services of a wetland or catchment area may involve wetland restoration or water pollution avoidance measures. Three main principles should thus be used to achieve Aichi Target 4:

- The impact mitigation hierarchy (Figure 3.5): The mitigation hierarchy includes avoidance, minimisation, restoration or rehabilitation and offset measures, to be adhered to in that order. This means that offset measures are a "last resort" activity, after all reasonable measures have been taken first to avoid and minimise the impact of a development project and then to restore biodiversity on-site.
- No-Net-loss / net-gains of biodiversity values (Figure 3.6): No-Net-Loss (“NNL”) refers to the point where biodiversity gains from targeted conservation activities (impact mitigation, restoration / restoration and offset measures) match the losses of biodiversity due to the impacts of a business activity or project. The type, amount and condition (or quality) of biodiversity need to be taken account. A net gain (or net positive impact) means that biodiversity gains exceed a specific set of losses.
- Equivalency Principle: To achieve NNL, biodiversity gains must be equivalent to losses in terms of biodiversity type, amount and condition (or quality).

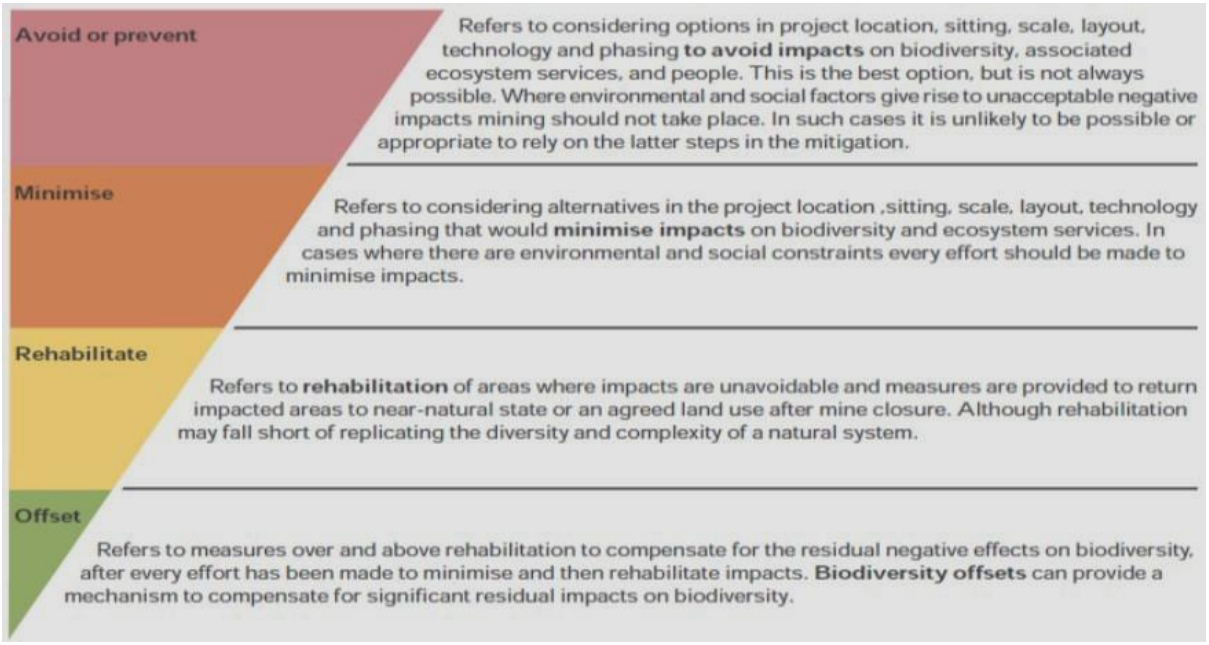


Figure 3.5: The Impact Mitigation Hierarchy (DEA *et al.*, 2013)

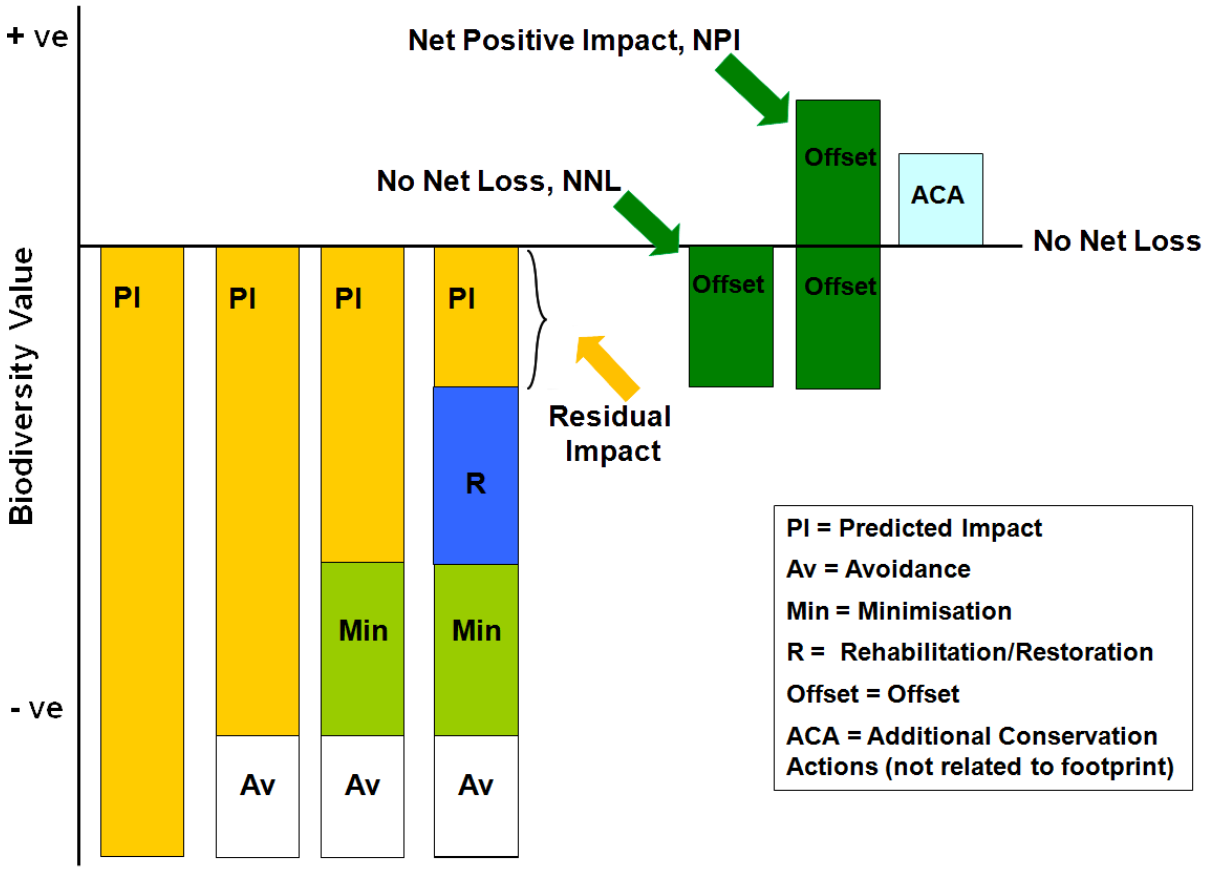


Figure 3.6: The Impact Mitigation Hierarchy, no-net-loss and net gain / net positive impact (BBOP 2013)

3.5 Progress towards Strategic Goal B: Restoring natural habitats, promoting sustainable harvesting and production, reducing pressures on coral reefs, effectively managing invasive species

Table 3.2 summarises the mainstreaming scores (i.e. progress towards reaching each Aichi Target) for the Aichi Targets of Strategic Goal B in Mauritius. More detailed explanations of each score is provided in sections 3.5.1 (Aichi Target 5), 3.5.2 (Aichi Target 6), 3.5.3 (Aichi Target 7), 3.5.4 (Aichi Target 8), 3.5.5 (Aichi Target 9) and 3.5.6 (Aichi Target 10).

Table 3.2: Progress towards reaching Aichi Targets of Strategic Goal B in Mauritius

Strategic	Aichi Target	Score	Short explanation
B - Reduce the direct pressures on biodiversity and promote sustainable use	5. By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.	2	A significant proportion of remaining natural or semi natural habitats are under some form of legal protection, but the protected area network is still far from complete. Focus on restoration of ecological integrity, with several successful projects over relatively small surface areas. Many challenges remain with invasive alien species.
	6. By 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits.	1	Coastal and marine ecosystems are under ongoing pressures, with many fish stocks depleted and significant proportions of all habitats degraded (rivers, estuaries, coral reefs, mangroves), restoration projects are planned.
	7. By 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.	1	Positive steps by the Forestry Service to plant native species (but exotic species are still the main ones used), very degraded ecological infrastructure in most farmlands and ongoing pollution (chemicals).
	8. By 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity.	1	No clear targets, no adequate monitoring/statistics (only focusing on chemical properties of water) and limited controls
	9. By 2020, invasive alien species and pathways are identified and prioritised, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.	1	National Invasive Alien Species Strategy and Action Plan has been developed but never really implemented.
	10. By 2015, the multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimised, so as to maintain their integrity and functioning.	1	Coral reefs under increasing pressures, no sign of recovery.

3.5.1. Restoring natural habitats

Aichi Target 5 states that, "*by 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced*." It is estimated that less than 2% of the remaining terrestrial native vegetation cover is in good[12] condition but marine habitats are in better condition (MAIF 2005). Though the current national parks are essentially secured (i.e. no encroachment), there are about 25,000 ha of forested land that are privately owned, or leased to private landowners with limited monitoring of the change in condition of their remaining natural habitats. In addition, small-scale efforts have been made to restore native forest (e.g. at Black River Gorges National Park and through the PAN project[13] on state and privately managed lands) and coral reef (e.g. demonstration coral nurseries and reef rehabilitation sites were established *in situ* at Albion, Flic en Flac and Trou aux Biches, through the collaboration between the MOI and the NGO Eli Africa, with the financial support of UNDP-GEF-SGP).

The RoM, with the support of GEF and UNDP, intends to soon begin the project "Mainstreaming biodiversity into the management of the coastal zone in the RoM". This project notably aims to demonstrate mechanisms to arrest land degradation in sensitive locations, focusing on reducing coastal erosion and sedimentation and helping to restore ecosystem functions in key wetland areas (Table 3.3).

Table 3.3: Environmentally Sensitive Areas (ESA), in hectares, to be addressed by the project "mainstreaming biodiversity into the management of the coastal zone in the RoM"

ESA Type	Location	Mauritius	Rodrigues	TOTAL
Seagrass and Algal Beds (ESA type 3.a)	Offshore	3,279	17,765	21,044
Coral Reefs (ESA type 3.b)	Offshore	6,306	7,005	13,311
Sand Beach and Dunes (ESA type 2.a)	Shore	2,885	80	2,893
Inter-tidal Mudflats (ESA type 1.f)	Wetlands	919	656	1,575
Coastal wetlands (ESA type 1.a)	Wetlands	406	0	406
Mangroves (ESA type 1.e)	Wetlands	145	24	169
Total ecosystem area to be addressed by the project (ha)		**13,940**	**25,530**	**39,470**

In direct link with Aichi Target 4 (analysis in 3.4.4), many ecosystems in Mauritius and Rodrigues have been so severely transformed and degraded that thinking in terms of reducing natural habitat loss, fragmentation and degradation is no longer appropriate. The focus should be on recreating resilient natural habitats and their capacity to supply a wide variety of ecosystem services, focusing on river corridors and proprieties of the potentially expanded PAN (see section 3.6.3).

3.5.2. Sustainable management and harvesting of aquatic resources

Aichi Target 6 states that, "*by 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery*

[12] Where good condition is defined as forest with native canopy of greater than 50% (Page and D'Argent 1997)

[13] The PAN Project refers to the GoM/UNDP/GEF 'Expanding coverage and strengthening management effectiveness of the protected area network on the Island of Mauritius'.

plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits." There is limited evidence of any progress on this aspect (apart from octopus fisheries in Rodrigues; MAIFS 2015), especially in freshwater systems which have been very degraded and remain understudied.

The project "Mainstreaming biodiversity into the management of the coastal zone in the RoM" is expected to generate positive impacts on marine and coastal resources (fish, crustaceans) by supporting:

- The incorporation of ESA recommendations into policies and enforceable regulations pertaining to integrated coastal zone management (ICZM). With a special focus on tourism and physical development in the coastal zone, threats to biodiversity and ecosystem functions and resilience will be mitigated.
- The effective management of marine protected areas (MPAs) across the RoM, given that they contain an important proportion of critically sensitive ESAs.

3.5.3. Sustainable agriculture, aquaculture and forestry

Aichi Target 7 states that, "*by 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity*." First, the Forestry Service (FS) is progressively moving towards sustainable forestry practices (Forestry Service 2014), with commitments to:

- Improve the management, protection, rational use and diversification of forest resources;
- Protecting the environmentally sensitive areas (ESAs) in forests to reduce soil degradation and enhance water conservation to ensure a steady supply of clean and fresh water for domestic and other purposes.
- Preserving our rich heritage of native species of plants, birds and animals, and;
- Developing facilities in forests for leisure and recreation.

About 50% of forest plantations have been set aside for environmental functions and soil and water conservation (mostly in water catchment areas and slopes) and, in line with the National Forest Policy (2006), timber exploitation is gradually being phased out in Mauritius and the exotic timber yielding species are gradually being replaced by native species (MAIFS 2015b). Yet, limited evidence of improvement in the biodiversity status of forestry lands is available to date (e.g. reforestation and afforestation is still mainly using exotic species, some of which are highly invasive; and very limited control of IAS occurs).

Secondly, aquaculture is a relatively limited activity in Mauritius. Twenty aquaculture lease fish farming sites have been promulgated in the Fish Farming Regulations 2014 under the Fisheries and Marine Resources Act. However, there is only a very limited number of fish farming operations, mainly on the east coast of Mauritius, such as the barachois specialising in oyster farming (e.g. Bambou Virieux) and the Ferme Marine de Mahebourg which produces Goldlined Sea Bream, Red Drum and Cobia in floating cages (UNDP – RoM – GEF, 2016, draft document). Fish farming is a scheduled activity under the Environment Protection Act 2002 (amended) so that all marine fish farming projects have to comply with operational guidelines for responsible fish farming practices,

and require an Environmental Impact Assessment (EIA) licence (DoE 2009). Yet, no data on environmental impacts on the surrounding marine ecosystems and associated management performance has been made publicly available to date.

Finally, there is also very limited progress in promoting sustainable agriculture practices, with an increase in use of agrochemicals under intensive production systems and export-oriented agricultural economy. Several studies have been undertaken at the Faculty of Agriculture, University of Mauritius, to determine the potential market for organic foods, and results have shown that airlines, hotels, supermarkets, private clinics, health shops, as well as a significant number of the general public interviewed expressed their eagerness to buy organic produce cultivated in Mauritius, even at slightly higher prices. Research on organic practices and sustainable agriculture have been conducted at the Faculty of Agriculture (UoM), which has demonstrated the success of a number of techniques for soil health and fertility management, and for integrated pest management, using non-chemical methods and natural plant-based chemicals that are permitted in organic production. With respect to pest control, FAREI has also tested a recommended range of bio-pesticides (natural or microorganism based pesticides) and has also introduced, multiplied and released parasitoids or predators for biological control of pest of economic importance (MAIFS 2015a). In 2013 MAIFS launched a compost purchase scheme to promote use of compost as a partial substitute to mineral fertilisers for small-scale planters (<10 ha). A range of imported bio-fertilisers are also marketed locally.

Yet, the interest for shifting from conventional farming to alternative, more sustainable farming practices (including organic farming) is restricted to a few farmers given the limited incentives, absence of standards, limited technical support and organic inputs. A pro-active policy framework, with incentives for pro-biodiversity practices and disincentives for harmful practices, is needed to support the opportunity costs (e.g. training, certification costs, loss of productivity) for shifting towards environmentally friendly food production systems. This should include diverse strategies to:

- Minimise the use of artificial inputs, including chemicals (pesticides, fertilisers) and water;
- Restore soil biodiversity;
- Restore freshwater systems on farmland (e.g. small streams and wetlands) with indigenous species to reduce erosion and restore ecological corridors from mountain to sea;
- Promote local breeds and varieties, and open new niche markets (especially targeting local businesses, especially in the tourism sector).

3.5.4. Reducing pollution to restore ecosystem function and biodiversity

Aichi Target 8 states that, "*by 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity*." Pollution of the aquifers by sewage, industrial waste water, refuse disposal and by poor agricultural practices is now widely acknowledged (MAIFS 2015a). The coastal areas and waters are the ultimate recipients for water emissions and solid waste. The threat of contamination of oligotrophic waters in Mauritius and deterioration in water quality by eutrophication and industrial wastes

(in particular metal pollution) have caused a decline coverage of live corals to 10-30% in coastal lagoons around Mauritius in 2012. Recent eutrophication in several Mauritius lagoons has highlighted the need for a greater understanding of nutrient sources to lagoon waters, with submarine groundwater discharge into the marine environment one possible transport mechanism for excess terrestrial nutrients to reach the sea (Ramessur 2013).

Accordingly, Mauritius and Rodrigues should develop island-wide, from mountain catchment to sea, water biodiversity conservation strategies and action plans focusing on:

- Setting up a comprehensive monitoring systems of not only water quality but also the condition and trends in aquatic biodiversity (plants, fishes, etc.);
- Assessing and disclosing the water use and emissions, on a catchment basis, of all water users on a monthly basis;
- Setting quantified water conservation and aquatic biodiversity targets for each catchment, aquifer and associated freshwater systems towards restoring their ecological integrity as much as possible;
- Setting up financial disincentives for wastewater / water emissions and water use (e.g. increased water user fees, tax on artificial lands) with the proceeds raised used exclusively for the improved management and ecological restoration of catchments and freshwater systems;
- Setting up financial incentives to promote water conservation and freshwater system restoration and stewardship (e.g. payments for ecosystem services, ecological engineering of urban development and infrastructure; see MAIFS 2017a and b).

3.5.5. IAS prevention, control and eradication

Aichi Target 9 states that, "*by 2020, invasive alien species and pathways are identified and prioritised, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment*." IAS pose the most serious current threat to the RoM's remaining terrestrial biodiversity.

At least 21 introduced species of mammals (e.g. mongooses, stray cats and dogs), reptiles and molluscs are naturalised (MAIFS 2015a). Animals such as the Rusa Deer (*Rusa timorensis*), introduced in 1639, browse native shrubs, saplings and seedlings. Feral pigs (*Sus scrofa*), introduced in 1606, disturb the soil, disperse seeds of alien plants and have negative effects on native plant regeneration. Pig predation was also probably partly responsible for the extinction of several ground-nesting endemic species such as the dodo and the giant tortoises and they may also affect ground-dwelling invertebrates. Macaques (*Macaca fascicularis*), introduced at the turn of the seventeenth century, damage unripe native fruits and eat the eggs and chicks of native birds. Rats (*Rattus rattus* and *R. norvegicus*), also predate on eggs and chicks, reptiles and invertebrates and are notable seed predators. Predation by a range of alien species appears to pose a very serious threat to the survival of endemic snails, which are often taken by Rats, Toads (*Bufo gutturalis*) and Tenrecs (*Tenrec ecaudatus*) and the Rosy Wolfsnail (*Euglandina rosea*).

More than 1,675 plant species have been introduced of which at least 20 plant species have been identified as particularly aggressive invaders (MAIFS 2015a). A diverse suite of invasive alien weeds is threatening all the remaining native forests. The worst species include Goyave de Chine (*Psidium cattleianum*) and Privet (*Ligustrum robustum* subsp. *walkeri)*. A recent aggressive forest invader is Liane Cerf (*Hiptage benghalensis*). These species, and many more, out-compete native plants for space, light and nutrients and quickly come to dominate the forests throughout the island.

The adoption of a National Invasive Alien Species Strategy and Action Plan (NIASSAP) for the RoM 2008-2017 (2009b) is based on key core best practice components, including:

- Prevention - to minimise the number of unintended and intended IAS introductions to the RoM;
- Early Detection and Rapid Response - to minimise the number of IAS that go on to have harmful consequences once they are introduced to the RoM;
- Eradication - an agreed framework for eradication priorities in place, eradications undertaken as necessary and results disseminated;
- Control and Management - to contain the distribution and abundance of IAS in the RoM to a long-term acceptable level;
- Restoration - to undertake ecosystem restoration where necessary in the RoM to achieve long-term ecosystem goals.

The NIASSAP is also based on important cross-cutting Elements:

- Legal, policy and Institutional Frameworks - to have a coordinated policy and management framework that minimises the risk of IAS to the economy, environment and society of the RoM;
- Capacity Building and Education - to make available appropriately skilled personnel from the RoM or elsewhere to implement all aspects of IAS management in the country;
- Information Management and Research - (i) To have a clear understanding of the economic, environmental and social impacts of IAS that have become established in the RoM; (ii) to have ready access to critical information that will support IAS management programmes and (iii) to provide a strong scientific basis for decision-making and resource allocation;
- Public Awareness and Engagement - The general public, decision-makers, scientists and other stakeholders in the RoM should have a high level of awareness of IAS risks and the benefits of IAS prevention and management for the economy, environment and society;
- International Cooperation – (i) The RoM should have access to the necessary information, technical support and other resources it needs to effectively meet its national and international obligations; (ii) Mauritian IAS experiences and lessons learned are effectively disseminated to help IAS initiatives regionally and internationally and (iii) the RoM is not a source of IAS for other countries
- Provision of Adequate Resources - It must be ensured that the IAS management system in place has sufficient human, technical and financial resources for its sustainable implementation.

Yet, despite the adoption of the strategy, very limited progress has been achieved to date both in terms of prevention (e.g. no IAS screening at airports for passengers and their luggage, no control of ballast waters at harbours) and of reducing predation and habitat invasion / transformation by invasive species, apart from a few islets (e.g. work spearheaded by MWF on Ile aux Aigrettes and Round Island) and some conservation management areas in the Black River Gorges National Park. The lack of human capacity and financial resources were often mentioned by consulted stakeholders.

Accordingly, political leadership and commitment is required to ensure adequate provision of resources for the implementation of the NIASSAP. This is a critical aspect of the Mauritius NBSAP, as it conditions the achievements of many Aichi Targets, including those linked to threatened species and natural habitat conservation (including coral reefs), the protected area system, sustainable forestry, agriculture and aquaculture, incentives harmful to biodiversity, biodiversity mainstreaming into public and private sector policies and planning processes, amongst others.

3.6.6. Minimising anthropogenic pressures on coral reefs

Aichi Target 10 states that, "*by 2015, the multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimised, so as to maintain their integrity and functioning*." For the past few decades, there has been an increase in both extent and severity of bleaching due to warm-water anomalies, which has led to the degradation of the Mauritian reef (Pillay *et al*., 2002; McClanahan *et al*., 2005). Reefs of the Mauritius lagoon have lost more than 50 - 60 % of their coral cover. Anchors and use of nets are also responsible for localised damage to corals. Reduction in coral reef habitats is posing a serious threat to biological diversity, as are unsustainable fishing practices (MAIFS 2015a).

In response to the on-going reef degradation in Mauritius, the MOI implemented a pilot coral farming project in 2008 for culturing corals under controlled conditions in land based nurseries. Culture techniques were developed for the ex-situ propagation of various coral species including fast-growing species, bleaching resistant species/strains and threatened species for conservation initiatives and rehabilitation of degraded lagoons of Mauritius. Further initiatives have been undertaken since but they cover very small surface areas.

In parallel, scientific monitoring of the marine environment was undertaken for the identification of resilient coral species and of appropriate sites to implement small-scale reef rehabilitation. Reef rehabilitation is essential to enhance its ecosystem functions such as increased habitat for growth in fish and coral recruitment. Hence, for the past seven years, fifteen permanent coral reef monitoring stations and an *in-situ* temperature network were established in-shore and off-shore at different sites around the island (RoM 2015).

The RoM, with the support of GEF and UNDP, is planning for the project "*Mainstreaming biodiversity into the management of the coastal zone in the RoM*" which will aim to address many of the challenges facing coral reefs. The following outcomes are envisaged:

- Outcome 1: Threats to biodiversity and ecosystem function are addressed by ensuring that 27,000 ha marine and coastal Environmentally Sensitive Areas (ESAs) (including coral reefs, with 6,306 ha of in Mauritius and 7,005 ha in Rodrigues) are an integral part of planning and implementation mechanisms relating to coastal development and the tourism sector;
- Outcome 2: Threats to marine and coastal biodiversity are mitigated and fishery resources protected in at least 20,000 ha of seascapes, through the improved management of MPAs and no-take zones;
- Outcome 3. Erosion control and ecosystem services restoration: erosion and soil loss are reduced in 200 ha of erosion-prone watersheds; and ecosystem services are restored in 100 ha of coastal wetlands.

In direct link with Aichi Target 4 recommendations (section 3.4.4), the principle of achieving no net loss and (ideally) net gains of biodiversity values should be progressively applied to all new coastal and marine development projects, from hotel development, infrastructure construction, aquaculture to even fishing operations eventually.

3.6 Progress towards Strategic Goal C: Protected Area Network, species and genetic diversity conservation

Table 3.4 summarises the mainstreaming scores (i.e. progress towards reaching each Aichi Target) for the Aichi Targets of Strategic Goal C in Mauritius. More detailed explanations of each score is provided in sections 3.6.1 (Aichi Target 11), 3.6.2 (Aichi Target 12), and 3.6.3 (Aichi Target 13).

Table 3.4: Progress towards reaching Aichi Targets of Strategic Goal C in Mauritius

Strategic Goal	Aichi Target	Score	Short explanation
C - To improve the status of biodiversity by safe- guarding ecosystems, species and genetic diversity	11. By 2020, at least 17 per cent of terrestrial and inland water, and 10 percent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.	2	Some progress achieved in expanding protected areas. Key challenge is their effective management, especially of IAS, for ecological integrity.
	12. By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.	2	Good progress for birds and reptiles. Some progress for plants but very little done for invertebrates and habitats.
	13. By 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio- economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity.	2	National strategy for the conservation and sustainable use of crop wild relatives adopted. It needs to be implemented. More work needed for local varieties and breeds.

3.6.1. Progress in bird species conservation, important gaps in other taxonomic groups

Aichi Target 12 states that, "*By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained*." Twelve species of land bird have so far escaped extinction. Of these, nine are threatened. Species recovery programmes have saved three of these species from probable extinction (RoM 2015):

- The Mauritius Kestrel (*Falco punctatus*) was once the rarest falcon in the world due to DDT poisoning with only four birds known in 1974. The kestrel population is now estimated to be around 350 - 400 birds.
- The Echo Parakeet (*Psittacula eques echo*) is the last surviving parrot in the Mascarenes. It was considered the rarest parrot in the world, with only about 12 individuals known in 1987 due to nest predation by invasive species and habitat loss. An intensive captive breeding and release programme, supplementary feeding, provision and monitoring of predator-proof nest boxes, and predator control have increased the population to about 650 – 700 birds.
- The Pink Pigeon (*Nesoenas mayeri*) now numbers around 400 birds, compared to a population of about 25 birds in the 1970s. There are now seven managed populations, five in the Black River Gorges National Park and one population on Ile aux Aigrettes.

Of the remaining forest bird species, the Mauritius Grey White-eye (*Zosterops mauritianus*) is common, the Mascarene Cave Swiflet (*Collocalia francica*) and the Mascarene Swallow (*Phedina borbonica*) are fairly common, while all the others are threatened. A recovery programme was initiated in 2003 to establish a population of the Mauritius Fody (*Foudia rubra*) on Ile aux Aigrettes (a rat-free islet). There are now about 200 - 250 birds on the island, and individuals began to breed in 2004. A recovery programme has also been initiated for the Mauritius Olive White Eye (*Zosterops chloronthos*). None of the other species: Mauritius Cuckoo shrike (*Coracina typica*), Mauritius black bulbul (*Hypsipetes olivaceus*), or Mascarene paradise flycatcher (*Terpsiphone bourbonensis* subsp*. desolata*) receive any active management.

In Rodrigues, the protection and monitoring of fauna concerns the Rodrigues fruit bat (*Pteropus rodricensis*), and two endemic and endangered bird species: the Rodrigues Fody (*Foudia flavicans*) and the Rodrigues Warbler (*Acrocephalus rodericanus*). Positive trends have been registered for three species (Table 3.5) because of the afforestation programme (albeit often with exotic species).

Table 3.5: Evolution of populations of some threatened species from 2000 to 2016 (MWF pers. com.)

Species	Year				
	2000	2009	2012/2013	2016	Trend 09 -16
Mauritius kestrel	700 birds	+/- 500 birds	362 birds	350 birds	Decrease
Mauritius cuckoo-shrike	300 - 350 pairs	>350 pairs	NA	100 – 250 birds	Decrease
Mauritius Black Bulbul	225 - 340 pairs	225 - 340 pairs	NA	900 birds	Increase
Pink Pigeon	400 birds	+/- 400 birds	410 birds	350 – 400 birds	Decrease
Echo Parakeet	120 birds	440 birds	550 birds	650 – 700 birds	Increase
Mauritius Fody	100 – 125 pairs	160 birds IAA	35 birds	240 – 330 birds	Increase
Mauritius Olive-white eye	<100 pairs	100 pairs	181 birds IAA	180 – 270 birds BRGNP, 56 birds IAA	Decrease
Mauritius Paradise Flycatcher	250 pairs	251 pairs	NA	800 birds	Increase

The situation for other taxonomic groups is less positive (lack of scientific baselines, expertise and capacity building) though knowledge has increased for reptiles. To date, there is no conservation strategy for any invertebrate group and any habitat / ecosystem type and there is a need to reinforce experts in this field area in Mauritius. Besides, 61 of the country's native plant species are already classified as extinct, 141 of the flowering Mascarene endemic plant species are classified as Critically Endangered, 55 species are endangered and 98 are classified as Vulnerable (NPCS unpublished report), though significant efforts have been made to conserve many of them. While, in 2012, 192 native plants species were classified as Critically Endangered as per International Union for Conservation of Nature criteria (IUCN), of which only 43 have been successfully propagated (NPCS, Digest of Environment Statistics 2013, Statistics Mauritius). Some recovery work is also undertaken in Rodrigues. For instance, the endemic Bois Papaye, *Badula balfouriana*, with only five remaining individuals in the wild, is being propagated in the MWF Solitude Nursery.

Accordingly, there is a need to develop a comprehensive species conservation strategy in Mauritius:

- There are major gaps in the understanding of the conservation status and levels of threat for many taxonomic groups (including plants, ferns, bryophytes, fungi, invertebrates, etc.);
- Science-based recovery plans and time-bound targets for all priority species (i.e. the most threatened ones) need to be developed, alongside local capacity building strategies;
- An IUCN Red List of Ecosystems[14] for Mauritius and Rodrigues is lacking. Given the importance of ecosystem restoration and re-wilding in Mauritius and Rodrigues, this should be seen as a priority.

[14] The IUCN Red List of Ecosystems Categories and Criteria is a global standard for how we assess the conservation status of ecosystems, applicable at local, national, regional and global levels. The Red List of Ecosystems evaluates whether ecosystems have reached the final stage of degradation (a state of Collapse), whether they are threatened at Critically Endangered, Endangered or Vulnerable levels, or if they are not currently facing significant risk of collapse (Least Concern). URL: http://iucnrle.org/

3.6.2. Towards an effective Protected Area Network

Aichi Target 11 states that, "*by 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes*." Accordingly, one needs to emphasise three key concepts for a successful protected area network, namely: (a) ecological representativeness, (b) effective and equitable management, and (c) adequate connectedness and integration in wider ecosystems to ensure their viability.

Mauritius – Terrestrial and inland freshwater PAN

Currently, the formal State Protected Area Network amounts to approximately 4%[15] of the surface area of Mauritius (Figure 3.7) and most of it is degraded by past land uses and invasive alien species (IAS). Rehabilitation and restoration efforts for both inland terrestrial and freshwater habitats and species therefore form a major part of achieving Aichi Target 11. There is broad consensus that the Protected Area Network (PAN) in its present form is not representative of all habitat types in Mauritius and does not adequately protect all species and/or the critical ecosystems required to maintain the ecological integrity[16] of the country's ecosystems. Indeed, species and native habitat outside of the PAN remain under threat from both IAS and development pressures, problems that are experienced in other countries in the world. Institutional overlap in the management of the various types of Protected Areas, as well as limited funding and skills, also hamper effective protected area management (MAIFS 2017c, draft document).

It is estimated that 25,000 ha of forested land are privately owned, or leased to private landowners. Much of this forest is managed for deer hunting with clearings for pasture. Some of the private land is classified as Mountain Reserve or River Reserve and receives legal protection. Mountain Reserves occupy the upper third of mountains. River Reserves vary in width from 3 to 16 m on each side, depending the size of the river. Deforestation is not permitted in these reserves but enforcement needs to be improved. There is little active conservation management of privately-owned forests apart from one private reserve on the land of Medine Sugar Estate comprising 5 hectares and managed by Mauritian Wildlife Foundation (leased to the Royal Society of Arts and Sciences of Mauritius until August 2013, when it was then leased to MWF for 20 years). There are also some innovative forest restoration projects associated to the development of nature-based tourism (e.g. Vallée de Ferney[17]). It has thus been concluded that:

- Management of protected areas needs to be strengthened; and
- Protected areas need to be expanded to be representative of all ecosystem types.

[15] Formal State Protected Areas as detailed in the Government of Mauritius (GoM)/United Nations Development Programme (UNDP)/Global Environment Facility (GEF) Project Document. 2010, p. 32.

[16] 'Ecological integrity' is a relatively new concept that is being actively discussed by ecologists and a consensus has not yet emerged as to its definition. In 1999, the British Columbia Parks Legacy Panel determined that an

[17] URL: http://www.valleedeferney.com/The-Nature-Reserve.

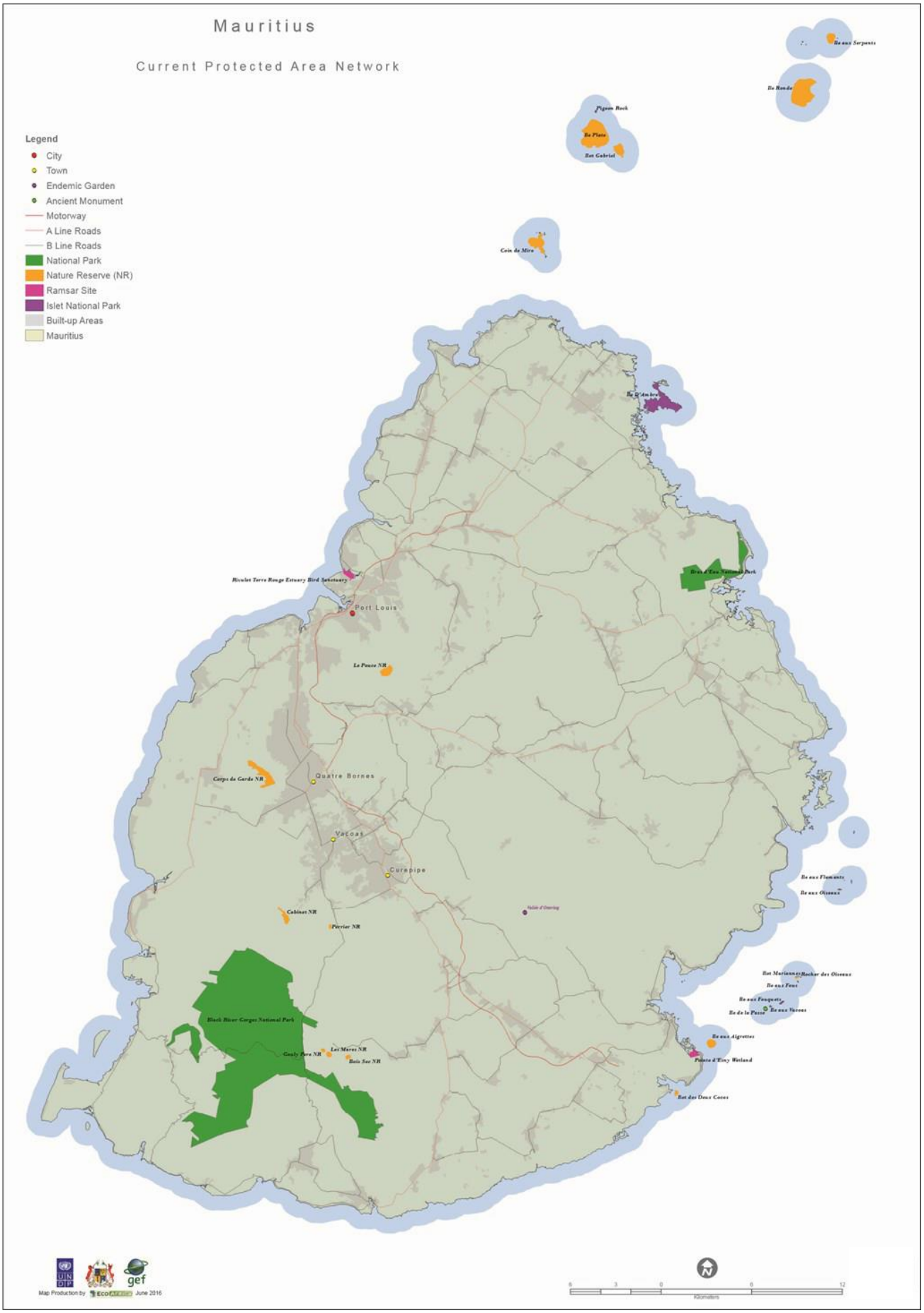


Figure 3.7: Current Protected Area Network of Mauritius including National Parks, Nature Reserves and Ramsar Sites (MAIFS 2017c, draft document)

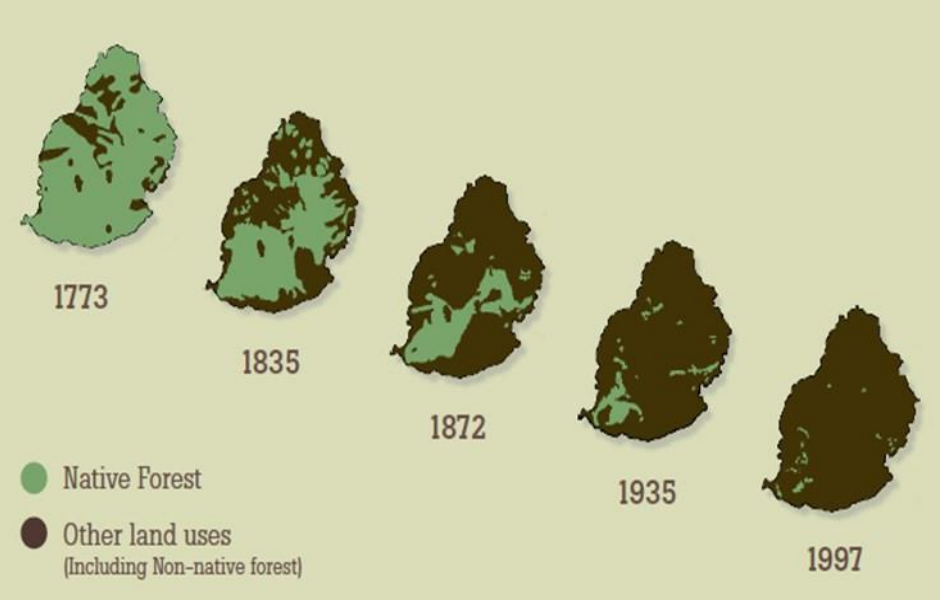


Figure 3.8: Degradation of native forest habitat in Mauritius (adapted from Page and D'Argent, 1997)

In response, the Government of Mauritius (GoM), with support from the United Nations Development Programme (UNDP) and funding from the Global Environment Facility (GEF), launched the project 'Expanding coverage and strengthening management effectiveness of the protected area network on the Island of Mauritius' (i.e. PAN Project). The overall objective of the PAN Project is to expand protected area coverage and to strengthen the management effectiveness of the existing Protected Areas (MAIFS 2017c, draft document). It further seeks to restore critical areas of biological significance and to maintain and improve ecosystem functions.

The potential PAN currently being identified includes all areas that have some form of protection and covers 16% (Figure 3.9), a percentage slightly below that of Aichi Target 11 (17%). This PAN must also be expanded further, primarily to private land falling outside the current network of Protected Areas and by filling in gaps between Protected Areas, in order to better represent the various ecosystem types in Mauritius (Figure 3.10; MAIFS 2017c, draft document). For PAN expansion to proceed on a well-founded basis, in an efficient manner, and within the context of Mauritian specificities, a carefully thought out and commonly agreed upon strategy is needed. The PAN Project is trying to bring all relevant stakeholders together in the implementation of the Protected Area Network Expansion Strategy (PANES) (ibid). However, effectively managing an expanded PAN will require innovative mechanisms and actions, especially on privately owned lands and leaseholds to private organisations.

The effective implementation of PANES requires an effective institutional framework that carries the support of all key parties, in particular MAIFS, on whom the onus lies to ensure the establishment and welfare of the PAN (MAIFS 2017d, draft document). Multiple sets of legislation have been enacted to meet new challenges in terms of the protection of specific species and components of habitats and ecosystem services in Mauritius (MAIFS 2017e, draft document). While every citizen, many Government departments, businesses, and NGOs have a role

to play in protecting the environment, the two lead institutions in terms of the PANES are the FS and the NPCS, which are currently working towards improved collaboration and integration of their respective services.

During the development of the PANES over the last two years, four major areas of competency were identified that need to be developed and institutionalised: Conservation Planning, Biodiversity Stewardship, Nature-based Tourism Development, and Invasive Alien Species (IAS) Control. The first two competencies are new to the institutions and, while a good start has already been made in terms of IAS control and nature-based tourism development, the latter can be considered to be in its infancy in the areas under control of the FS and the NPCS. However, although a relatively new concept in the country at large, the potential of nature-based tourism has been recognised, and it is receiving increasing support from the MT (MAIFS 2017f, draft document).

Several other key aspects for an effectively managed and equitable PAN need to be emphasised:

- The aforementioned competency areas should apply to all PAN properties, irrespective of their ownership or managing authority[18].
- Ecological integrity should the primary principle underpinning the PAN and overriding any other PA management aspects, such as tourism.
- To achieve this, Mauritius should strive to mimic other leading islands in restoring its biodiversity values (e.g. adopting ambitious biodiversity restoration and re-wilding targets for the whole PAN), namely through the full ecological restoration of islets (e.g. efforts at Ile aux Aigrettes and Round Island, in the Galapagos Archipelago[19], Channel Islands[20], and various islands in the Seychelles – Russell *et al*., 2016) and through the developments of ecologically representative "mainland islands" throughout its PAN which would fully exclude exotic predators (such as that adopted by Zealandia Sanctuary in New Zealand[21]). This is one of the most promising ways for Mauritius to be able to compete with other island eco-tourism destinations in a world where tourists are becoming more knowledgeable, have easy access to information and want value for money.
- Another key aspect of an effective PAN is its full integration in surrounding landscapes and seascapes though well-connected systems of PA allowing for full ecosystem processes to take place in the context of climate change, such as mountain to sea hydrological and ecological migration processes.
- Best practices in PA management involves regular, independent PA management effectiveness assessments (e.g. via independent auditors or multi-stakeholder panels using tools such as the METT) as per CBD guidelines[22].

[18] The Native Terrestrial Biodiversity and National Parks (NTBNP) Act 2015 provides for the designation of private reserves.
[19] URL: http://www.galapagos.org/conservation/conservation/project-areas/ecosystem-restoration//.
[20] URL: https://www.nps.gov/chis/learn/nature/island-restoration.htm
[21] Zealandia is a fully-fenced urban private reserve, with an extraordinary 500-year vision to restore a Wellington valley's forest and freshwater ecosystems as closely as possible to their pre-human state. The 225 hectare 'ecosanctuary' is a ground-breaking conservation project that has reintroduced 18 species of native wildlife back into the area, 6 of which were previously absent from mainland New Zealand for over 100 years. URL: https://www.visitzealandia.com/.
[22] URL: https://www.cbd.int/protected-old/PAME.shtml.

- For biodiversity stewardship to be successful in Mauritius on properties with land owners or users requiring incentives to change their land management practices the full opportunity costs (e.g. loss of revenues and land value, transaction costs) of required changes need to be embedded in appropriate compensation packages. Indeed, in other countries which have experimented with stewardship, most financial incentives (including tax reductions) were found to be weak or unhelpful to convince target stakeholders, so that only marginal lands or properties not requiring financial incentives (i.e. landowners keen to support conservation) joined the program (e.g. SANBI and Wildlands Conservation Trust, 2015).
- Finally, the financial viability of the PAN needs to be become a priority so as to enable the funding of ambitious biodiversity restoration and re-wilding targets (e.g. good ecological condition for the whole PAN by 2026). For this to be achieved, a few key points need to be emphasised:
    - Restoring ecological integrity of the PAN drive fundraising efforts.
    - A diverse set of funding sources (public and private) must be secured, with non-sinking endowment funds an interesting option to consider for funding critical conservation work (e.g. only interests or income used for conservation purposes; e.g. Bladon *et al.*, 2014; GEF 1998).
    - Nature-based tourism is highly unlikely to make all individual PA financially viable, with a few tourism products likely to generate the most revenues for the benefit of other PA (e.g. in South Africa, only a few national parks managed by SANPARKS are financially viable and they effectively subsidise the effective management of the rest of the SANPARKS PA network; SANPARKS 2016).
    - All public revenues generated by the PAN must be reinvested back into the PAN. In other words, no revenue generated by PAN-related government run activities should be used to support any other government activity.
    - Ecosystem-based adaptation opportunities should drive new fundraising initiatives.

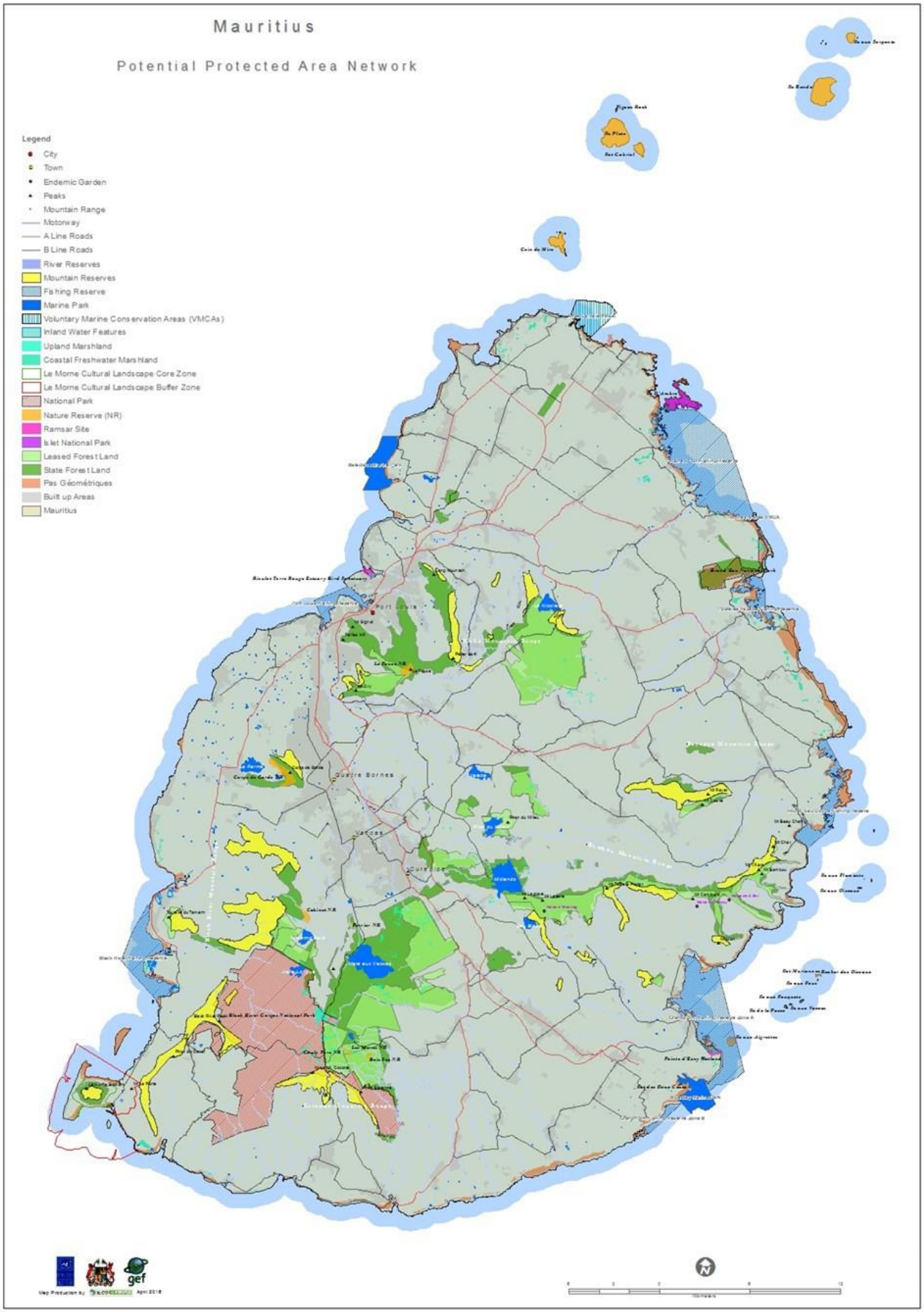


Figure 3.9: Potential Protected Area Network with various Protected Areas having some degree of protection (MAIFS 2017c, draft document)

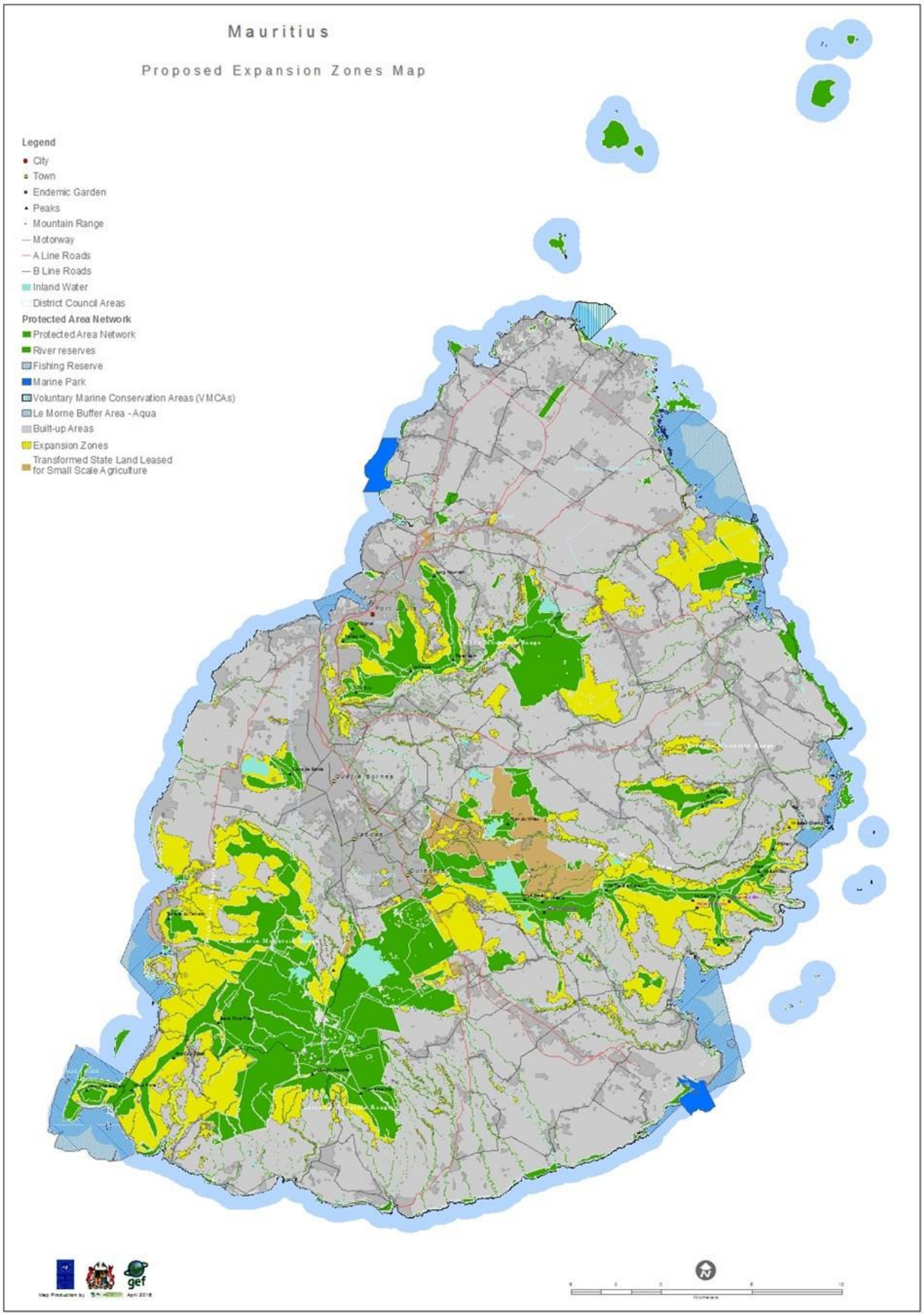


Figure 3.10: Potential Protected Area Network (green) and the proposed Expansion Zones (yellow) (MAIFS 2017c, draft document)

Mauritius – Coastal and MPA

Currently, an estimated 9,150 ha of the marine environment are legally protected on Mauritius (two Marine Parks, six Fishing Reserves), with an additional area of 1960 ha within the buffer zone of the Le Morne Cultural World Heritage Site (Table 3.6). Management plans have been prepared for both Marine Parks but have not been formally approved and are thus not being directly implemented. There are no management plans for the Fishing Reserves and there is minimal enforcement of the fishery regulations that apply to them (METT score of 29%; UNDP – RoM – GEF, 2016, draft document).

Table 3.6: Protected Areas in Mauritius with marine and coastal components (UNDP – RoM – GEF, 2016, draft document)

Protected Area	Year designated	Area ha	IUCN Category
Marine - Mauritius			
Blue Bay Marine Park	1997/2000	353	II
Balaclava Marine Park	1997/2000	485	II
Poste Lafayette Fishing Reserve	1983/2000	280	IV
Poudre d'Or Fishing Reserve	1983/2000	2,542	IV
Trou d'Eau Douce Fishing Reserve	1983/2000	574	IV
Port Louis Fishing Reserve	1983/2000	331	IV
Grand Port Mahebourg Fishing Reserve	1983/2000	1828	IV
Riviere Noire Fishing Reserve	1983/2000	797	IV
Le Morne Cultural WHS marine buffer zone (marine area only)	2006	1,960	
Total MPA Mauritius (excl. WHS)		**7,190**	
Coastal Wetlands			
Rivulet du Terre Rouge Bird Sanctuary & Ramsar Site	1999/2001	26	
Blue Bay Ramsar Site (as for Marine Park)	2008	353	
Pte d'Esny Wetland Ramsar Site	2011	22	
Total Coastal Wetlands		401	

The only designated no-take area is the Strict Conservation Zone is Blue Bay Marine Park (BBMP) covering 9 ha, but the rules are frequently violated; the Voluntary Marine Conservation Areas (VMCAs) being launched in the north will also be no-take areas but cover a very small area.

The Le Morne Cultural WHS was designated as a UNESCO World Heritage Site in 2008, and includes a Core Zone and Buffer Zone. Some 60% of the Buffer Zone covers the lagoon, and this is an important component of the WHS as the maroon slaves used marine resources; traditional fishing practices are thus considered part of the cultural heritage of the area. This has necessitated production of a Lagoon Management Plan, developed in consultation with local communities and fishers, and which proposes a zoning plan for the area (UNDP – RoM – GEF, 2016, draft document). However, this has yet to be implemented. Fishers have been unwilling to consider no-take zones and wanted compensation.

The only nationally designated protected area for coastal wetlands is the Mare Sarcelle Nature Reserve, within the Bras d'Eau National Park. There are also three Ramsar site, two of these are important habitats for more than a dozen regularly visiting migratory bird species and one of which (Blue Bay Marine Park) is designated for its coral reef biodiversity.

Ensuring effective MPAs in the RoM has proved difficult (UNDP – RoM – GEF, 2016, draft document). The GEF Management Effective Tracking Tool (METT) was used in the course of the previous UNDP/GEF Project "Partnerships for Marine Protected Areas in Mauritius". For the Marine Parks in the island of Mauritius, the scores showed slight progress as a result of that initial project, rising from 35- 40% at the beginning of the project to 44-45% at the end. Based on the METT assessment recently undertaken, management effectiveness of BMP has declined (now 39%) (ibid). For Blue Bay Marine Park, there appears to have been a significant increase in effective management (current score 66%) but the management team considers this an over-estimate due to inexperience in undertaking the METT (no implementation of management plan yet).

The RoM, with the support of GEF and UNDP, intends to soon begin the project "*Mainstreaming biodiversity into the management of the coastal zone in the RoM*" which will aim to address some of these challenges. Particular attention must be given to science-based restoration and protection target setting, effective and equitable management and financial sustainability. For instance, for certain activities, permits are issued which vary in price from USD3.00 to USD1600. This income however is returned to the Government and is not retained by the MOEMRFS for MPA management. Section 8 of the Fisheries and Marine Resources Act allows for the establishment of a Marine Protected Area Fund which would consist of funds raised through donations, user fees or other revenue from the MPAs, with the intention that this money would be used for MPA management, but this has yet to be put in place.

Rodrigues – Terrestrial and inland freshwater PAN

In Rodrigues, Grande Montagne (25.5 ha), Anse Quitor (35 ha) and two islets to the west of the island, Ile aux Sables (8 ha) and Ile aux Cocos (14.4 ha) have all been declared Nature Reserves (under the Forest and Reserves Act 1983). Management plans have been prepared for Ile aux Sables, Ile aux Cocos as well as Gombrani Island and Crab Island (which are also of potential conservation importance).

The FS and the MWF have undertaken significant work in the restoration of Grande Montagne and Anse Quitor reserves where between 300,000 and 450,000 native and endemic plants have been planted to date. There is a private sector project by Francois Leguat Ltd to recreate 20 hectares of original forest close to Anse Quitor[23]. So far 186 000 plants of 40 native species, including 25 endemic ones, have been planted. This project is inspired by re-wilding principles with the introduction of two surrogate tortoise species that mimic the roles of the local extinct tortoise species in shaping the ecosystems.

Naturally, a lot of work is still needed to restore the biodiversity values and re-wild Rodrigues. Lessons to be learned from the PANES and recommendations made in section 3.4.4. (e.g. ambitious restoration and re-wilding targets, financial sustainability through diverse source of funds and revenue retention in PA system, landscape approach, etc.) should support the development of a local strategy for an effective and equitable PAN for Rodrigues Island and its surrounding islets. mm

Rodrigues – Coastal and MPA

On Rodrigues, there are 4 Marine Reserves and a multiple-use Marine Protected Area (SEMPA) (Table 3.7). A draft Management Plan has been prepared for the Northern Marine Reserves (as a group), and while the Management Plan for SEMPA has been formally approved, it has yet to be implemented. Five Fishery Reserved Areas (not listed in Table 3.7) established under old colonial legislation are no longer managed. Responsibility for marine, as well as coastal and terrestrial, protected areas lies with the RRA.

[23] URL: http://www.tortoisescavereserve-rodrigues.com/

Table 3.7: Protected Areas in Rodrigues with marine and coastal components (UNDP – RoM – GEF, 2016, draft document)

Protected Area	Year designated	Area ha	IUCN Category
Marine – Rodrigues			
South East Marine Protected Area SEMPA	2009	4,343	VI
Riviere Banane Marine Reserve	2007	153	
Anse aux Anglais Marine Reserve	2007	152	
Grand Basin Marine Reserve	2007	1,396	
Passe Demi Marine Reserve	2007	719	
Total MPA Rodrigues		**6,763**	

Total no-take area on Rodrigues is 3,684 ha. Four Marine Reserves cover 2,421 ha and 11 conservation zones within SEMPA cover 1,263 ha or 30% of the entire MPA. In addition, there has been greater success with MPA management in Rodrigues than in Mauritius, presumably due to the effectiveness of the co-management approach used there (UNDP – RoM – GEF, 2016, draft document). For SEMPA, the METT score increased from 8% at the beginning of the UNDP/GEF Partnerships for MPAs project to 71% at the end. However, with the end of funding from the previous project, the capacity for management has noticeably declined, and the METT score for SEMPA during the PPG phase had dropped to 63%. The METT was completed for the Northern Marine Reserves during preparation of the Management Plan for these sites, when the score was 26% (25 out of 96) and the current METT score is 44%.

Nevertheless, for all the designated MPAs there is a need for further investment to fully implement the draft Management Plans and ensure effective management. Particular attention is needed to mechanisms for managing the watersheds to reduce negative impacts on the MPAs. The connection between the management of land activities and that of the MPA itself appears to have not been emphasised, with uncontrolled activities very clearly taking place both on the shore and on the adjacent land, with a lack of proper trash collection facilities and other visible shortcomings. Fundamental to the lack of effective management is the fact that there is no sustainable financing mechanism.

The RoM, with the support of GEF and UNDP, intends to soon begin the project "*Mainstreaming biodiversity into the management of the coastal zone in the RoM*" which will aim to address some of these challenges. Particular attention must be given to science-based restoration and protection target setting, effective and equitable management and financial sustainability.

3.6.3. Challenges remain in the conservation and promotion of local land races, local varieties/breeds and crop wild relatives

Aichi Target 13 states that, "*by 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversi*ty." Several institutions are involved in various activities to conserve and / or improve genetic diversity, such as:

- The 471 crop seed accessions in the seed gene bank manned by the Plant Genetic Resources Unit (PGRU) of MAIFS, consisting amongst others of the following genera: *Amaranthus, Allium, Brassica, Cucurbita, Lycopersicon, Phaseolus, Solanum, Abelmoschu*s and *Vigna*.
- The 104 accessions of vegetatively propagated crop conserved as *ex situ* accessions in the field gene bank of the PGRU. These include *Ipomoea batatas*, *Musa* spp., *Manihot esculenta*, *Colocasia* spp. amongst others
- The characterisation and utilisation, breeding and improvement works on many crop varieties by the Food and Agricultural Research and Extension Institute (FAREI).
- Some wild crop relatives of the cultivated species of *Lycopersicon* spp., *Cajanus* spp., *Cucumis* spp. and *Solanum* spp. conserved in the seed genebank.
- The activities of the Curepipe Livestock Research Station, the only government station on the island for research on cattle (Creole, Friesian and their crosses), goats (Local, Boer, and Boer crosses), sheep (Dorper and Dorper crosses) and rabbit (New Zealand white, Californian white crosses and Black Beveren crosses).

In Mauritius, there is no comprehensive characterisation and conservation *in situ* and *ex situ* of the genetic diversity of local land races, local varieties / breeds and crop wild relatives. Collaboration between the FAREI, the University of Mauritius (UoM) and MAIFS should be actively promoted and mechanisms for auditing the viability and integrity of *in situ* and *ex situ* collections should be set up. And, perhaps more importantly, innovative mechanisms need to be developed to promote their use by farmers, as currently most efforts are focused on a limited number of imported cultivars and breeds.

3.7 Progress towards Strategic Goal D: Nagoya Protocol implementation, maximising ecosystem services supply and delivery, improving the contribution of biodiversity to carbon stocks

Table 3.8 summarises the mainstreaming scores (i.e. progress towards reaching each Aichi Target) for the Aichi Targets of Strategic Goal D in Mauritius. More detailed explanations of each score is provided in sections 3.7.1 (Aichi Target 14), 3.7.2 (Aichi Target 15), and 3.7.3 (Aichi Target 16).

Table 3.8: Progress towards reaching Aichi Targets of Strategic Goal D in Mauritius

Strategic Goal	Aichi Target	Score	Short explanation
D - Enhance the benefits to all from biodiversity and ecosystem services	14. By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.	1	Very limited spatially-explicit assessment of the supply and delivery of ecosystem services to different stakeholder groups available in Mauritius and Rodrigues. Very limited restoration work to date.
	15. By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.	1	Very limited restoration progress to date. Ecosystem based study undertaken.
	16. By 2015, the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization is in force and operational, consistent with national legislation.	1	Nagoya Protocol ratified but specific legislation pending. No projects yet.

3.7.1. The need to map ecosystem services supply and delivery to different stakeholder groups to prioritise restoration efforts

Aichi Target 14 states that, "*by 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable*." Though some ecological restoration work has been undertaken in some PAs (e.g. Black River Gorges National Park, Grande Montagne and Anse Quitor reserves), to date, there is no spatially-explicit assessment of the supply and delivery of ecosystem services to different stakeholder groups available in Mauritius and Rodrigues, besides expert knowledge on the benefits that various habitats generate (e.g. coral reefs, seagrass meadows, forests, wetlands). Such assessments would be a pre-requisite to prioritising which ecosystems should be restored first, so as to maximise the supply and deliver of essential ecosystem services to the population and businesses. This is directly linked to Aichi Target 4 and the associated recommendations made in section 3.4.4 (e.g. net gains targets through the mainstreaming of the impact mitigation hierarchy and equivalency principles to all development projects and business activities).

3.7.2. The need to restoration ecosystem resilience and the contribution of biodiversity to carbon stocks

Aichi Target 15 states that, "*by 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification*." As previously discussed, there has been very limited forest restoration efforts to date. The challenge lies in controlling IAS at the same time, which are often trees and shrubs, thus leading to the loss of carbon stocks. An ecosystem-based adaptation study for the PAN has explored the risks and opportunities for various types of protected areas (MAIFS 2017b).

3.7.3. Implementing the Nagoya Protocol

Aichi Target 16 states that, "*by 2015, the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization is in force and operational, consistent with national legislation*." In the last decade, Mauritius has been progressively involved in new biotechnologies, with various institutions devoted to agricultural research, as well as human and animal health, presently involved in biotechnology (MAIFS 2015a). Although Mauritius ratified the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits in 2013, clear mechanisms for implementing it still need to be put in place. This should be seen as a priority so as to enable the fair and equitable benefit sharing of future benefits arising from the development and commercialisation of products from local genetic resources falling under the scope of the Nagoya Protocol[24]. This is directly linked to the need to better recognise the value of Mauritius' biodiversity (Aichi Target 1), including the genetic resources of the marine environment.

3.8 Progress towards Strategic Goal E: Sharing knowledge, the science base and technologies, mobilising financial resources for an effective implementation of the NBSAP

Table 3.9 summarises the mainstreaming scores (i.e. progress towards reaching each Aichi Target) for the Aichi Targets of Strategic Goal E in Mauritius. More detailed explanations of each score is provided in this section.

[24] The 64 species covered by the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) are not covered by the Nagoya Protocol.

Table 3.9: Progress towards reaching Aichi Targets of Strategic Goal E in Mauritius

Strategic Goal	Aichi Target	Score	Short explanation
E - Enhance implementation through participator planning, knowledge management and capacity building	17- By 2015 each Party has developed, adopted as a policy instrument, and has commenced implementing an effective, participatory and updated national biodiversity strategy and action plan	1	New NBSAP 2017-2025 about to be adopted, with broad stakeholder consultation, but no effective progress monitoring and lack of leadership to date
	18- By 2020, the traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological re- sources, are respected, subject to national legislation and relevant inter- national obligations, and fully integrated and reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels.	0	No indigenous people in Mauritius. All descendants of immigrants.
	19- By 2020, knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.	1	Lack of knowledge and no effective sharing mechanism to date.
	20- By 2020, at the latest, the mobilisation of financial resources for effectively implementing the Strategic Plan for Biodiversity 2011-2020 from all sources, and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilisation, should increase substantially from the current levels. This target will be subject to changes contingent to resource needs assessments to be developed and reported by Parties.	1	No stakeholder-based budget needs assessment, access to information problematic.

While Aichi Target 17 ("*by 2015 each Party has developed, adopted as a policy instrument, and has commenced implementing an effective, participatory and updated national biodiversity strategy and action plan*") is in the process of being achieved, stakeholders have voiced doubts about the relevance of Aichi Target 18[25] in the RoM.

Indeed, while the concept of indigenous communities does not apply to Mauritius (i.e. people are descendants of successive waves of immigrants from various countries), most community-based uses of natural resources have negatively impacted the indigenous biodiversity (e.g. overfishing, overharvesting leading to species extinction, introduction of invasive species), though some traditional farming practices have led to the evolution of local breeds and cultivars.

[25] Aichi Target 18 states that, "*by 2020, the traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels.*"

Aichi Target 19 states that, "*By 2020, knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied*." Besides the knowledge gaps previously mentioned, very limited information is currently shared and transferred between stakeholders (apart from close partners involved in conservation or research work), including civil society and the broader public, and most importantly there is no effective NBSAP progress monitoring and implementation.

The development of a new Clearing-House Mechanism (CHM) website should help address this but this will not be sufficient in itself. Sustained commitments and collaborations between all stakeholders need to be ensured. This target is also directly linked to Aichi Targets 1, 2 and 4 and, more specifically, the development and implementation of an integrative biodiversity valuation and value monitoring framework for Mauritius and Rodrigues, for use within specific public, private and community-based policy, decision-making, planning, accounting and reporting processes.

Finally, Target 20 states that, "*by 2020, at the latest, the mobilisation of financial resources for effectively implementing the Strategic Plan for Biodiversity 2011-2020 from all sources, and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilisation, should increase substantially from the current levels. This target will be subject to changes contingent to resource needs assessments to be developed and reported by Parties".* Biodiversity-related funding for achieving the Convention's three objectives can be in the form of: (a) Official Development Assistance (ODA); (b) Domestic budgets at all levels; (c) Private sector; (d) non-governmental organisations, foundations, and academia; (e) international financial institutions; (f) United Nations organisations, funds and programmes; (g) non-ODA public funding; (h) South-South cooperation initiatives; and (i) Technical cooperation (SCBD 2011). To date, Mauritius and Rodrigues have yet to:

- Identify and report funding needs, gaps and priorities;
- And develop national financial plans for biodiversity activities as per its Aichi Targets.

4 CONCLUSIONS

Much needs to be done towards meeting the country's obligations under the Convention on Biological Diversity (Article 6a) and providing a strategic approach for biodiversity management in Mauritius for the coming decade (2016–2025). Stakeholders are aware of the importance of natural capital, but the lack of understanding of the diverse values of nature is preventing them from addressing the underlying causes of biodiversity loss. Mainstreaming biodiversity across government and society requires natural capital / ecosystem assessment, monitoring, valuation and reporting systems for both the public and private sectors, addressing perverse subsidies, developing and implementing new production models and educating all stakeholders and citizens. Furthermore, to effectively reduce the direct pressures on biodiversity, restore biodiversity and natural habitats, improve the status of threatened species and genetic diversity, maximise ecosystem services delivery to all, and promote knowledge sharing, significant resources will have to be secured and invested. While partnerships with both international donors and the private sector should be sought, it is also important to recognise that pro-active changes in existing practices, through notably targeted capacity building and sustained leadership, can bring about significant benefits towards pro-biodiversity development pathways for the RoM.

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REPUBLIC OF MAURITIUS

Ministry of Agro-Industry and Food Security

STUDY 2

Valuation of ecosystem services provided by the Mare Longue and Mare aux Vacoas catchments

May 2017

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Acronyms

CWA	Central Water Authority
GEF	Global Environment Facility
ha	Hectare
MAIF	Ministry of Agro-Industry and Fisheries
MAIFS	Ministry of Agro Industry and Food Security
MAV	Mare aux Vacoas
Mgmt	Management
ML	Mare Longue
MWF	Mauritian Wildlife Foundation
N/A	Not applicable
NBSAP	National Biodiversity Strategy and Action Plan
NPCS	National Parks and Conservation Service
UK	United Kingdom
WTP	Willingness to pay

Summary

The objective of this study was to explore how environmental valuation may be able to inform land use decision-making in the catchments of the Mare Longue (ML) and Mare aux Vacoas (MAV) reservoirs, and investigate how such an approach could be linked to the national environmental accounts. The background to this study is the period of drought when water levels in MOV were around half as much as their long-term average whereas those in ML were considerably higher. It was suggested that this might be in part be due to 4,500 hectares of indigenous forest being replaced by pine trees in the Mare aux Vacoas catchment between 1969 and 1974. Pine trees use up far more water through evapotranspiration than indigenous trees in many ecosystems. In addition, a diverse suite of invasive alien weeds is threatening the remaining native forests. Many of these plants also have high evapotranspiration rates, potentially affecting water availability in the reservoirs. Other contentious land management issues in the catchments include the clearance of vegetation for agriculture and unsustainable management of forests for deer and pig hunting. These activities can also have direct and indirect impacts on water availability and biodiversity within the catchments.

The analysis required valuation of various alternative land and water catchment management options in the upper rainfall catchments of the reservoirs. A key study hypothesis is that alternative land management scenarios will result in a different mix of land cover with different associated evapotranspiration rates. Four different land use management scenarios are considered for each reservoir upper catchment. The scenarios are: 1) Do nothing – what might may happen if there is no management at all in the catchments; 2) Basic management (business as usual); 3) Proposed improved management - how things are likely to look in the coming years; 4) Ideal balanced management –where money is no constraint. This would involve converting much of the pine tree cover to native vegetation, as well as intensive invasive weed control.

Each scenario assumes the same current baseline and a straight-line change over 10 years to the projected scenario conditions and a constant level for the remaining 15 years. The following main values were assessed: water saved from reduced evapotranspiration; conservation values held by Mauritians and international visitors; recreational value of Mauritians and international visitors; hunting value; agriculture, and; carbon sequestration.

Results for both ML and MOV, aggregated over a 25-year period and discounted at 3%, indicate that Scenario 4 would generate most benefits with benefits diminishing to Scenario 2 which generated the least value. For ML Scenarios 1, 2, 3 and 4 would generate total benefits of Rs 0.5 billion, Rs 1.1 billion, Rs 1.8 billion and Rs 2.5 billion respectively. Comparative figures for MOV were Rs 0.9 billion, Rs 1.7 billion, Rs 2 billion and Rs 2.4 billion respectively. Principal sources of increased value were water saved, conservation and recreation.

The results suggest that significant economic benefits can be gained through improved catchment management. In addition to the welfare benefits generated by the outcomes of each scenario, Scenarios 3 and 4 in particular would directly result in a significant number of jobs for local people to help clear the invasive species and plant native species. Furthermore, these scenarios could lead to relatively significant additional employment through enhanced visitors and associated spending. A key overall conclusion is that CWA could potentially charge consumers more for consuming water, with part of that revenue being invested back into management of the pine trees and invasive plants in the two catchments.

Scenarios 3 and 4 would significantly contribute to the 2017 NBSAP and the following Aichi Targets: 7 - Sustainable agriculture, aquaculture and forestry; 9 – Invasive alien species prevented and controlled; 14 - Ecosystems and essential services safeguarded, and; 15 - Ecosystems restored and resilience enhanced.

This pilot study presents an important example of how economic valuation, coupled to natural capital accounting, can help improve decision-making. By developing and regularly monitoring precise natural capital / ecosystem accounts, the country will be able to develop credible and reliable scenarios of change to explore alternative land use options, the expected costs and benefits for targeted or impacted stakeholders and the associated budget requirements.

This study is based on some key assumptions which need to be investigated further to improve the accuracy of the valuation work. The following parameters, in particular, should be investigated: site visitor numbers, willingness to pay values, evapotranspiration rates and carbon sequestration rates.

1. INTRODUCTION

This ecosystem services valuation study aimed to investigate the value and optimum management of ecosystem services around the Mare Longue (ML) and Mare aux Vacoas (MAV) reservoirs. The need for the study arose from several challenging stakeholder questions that were brought up after periods of drought when water levels in the reservoirs dropped significantly, including:

- Whether the existing pine forest, which is renowned for its high water consumption, should be converted to native forest cover around the reservoirs; and
- To what extent should invasive alien plant species in the catchments be controlled?

The objective of the study was to explore how environmental valuation may be able to help inform land use decision-making at these two reservoirs, and investigate how such an approach could be linked to the national environmental accounts.

2. BACKGROUND TO THE CATCHMENTS

The Mare aux Vacoas reservoir was first constructed in 1885. This involved damming the Rivière du Tamarin, with three feeder canals being constructed between 1922 and 2002. Then, in 2011/12, an additional canal was constructed between Mare Longue and Mare aux Vacoas to enable water to flow from Mare Longue to supplement Mare aux Vacoas in times of need. This construction was undertaken during a period of drought, when water levels in Mare aux Vacoas were around half as much as their long-term average between October 2010 and May 2012 (Statistics Mauritius, 2015). In contrast, Mare Longue, built in 1948, has had greater than the average water levels in it between 2007 to 2014 (ibid). See Annex 1 for details of the reservoir water levels.

When water levels in Mare aux Vacoas were so low in 2010 to 2012, especially compared to water levels in Mare Longue, questions were asked as to what the possible causes were. Dr Vikash Tatayah, Conservation Director at Mauritian Wildlife Foundation (MWF) suggested it might in part be due to 4,500 hectares of indigenous forest being replaced by pine trees in the Mare aux Vacoas catchment between 1969 and 1974 (L'Express, 13 Jan 2012; journalist: Ronnie Antoine). He highlighted that pine trees use up far more water through evapo-transpiration than indigenous trees in many ecosystems, as shown in several areas of the world (e.g. Fetene & Beck, 2004 in Ethiopia; and van Wilgen & Richardson, 2012 in South Africa). A related problem is that there now remains around 2% good quality land-cover of native (indigenous) trees in Mauritius (i.e. that with more than 50% native tree cover) (MAIFS, 2015).

A diverse suite of invasive alien weeds is threatening the remaining native forests, with Chinese guava (*Psidium cattleianum*), privet (*Ligustrum robustum* subsp. *walkeri*) and ravenal (*Ravenala madagascariensis*) being some of the worst invaders. These species, and many more, out-compete native plants for space, light and nutrients and have quickly come to dominate the forests throughout

the island (MAIFS, 2005). Many of these invasive plants also have high evapotranspiration rates, potentially affecting water availability in the reservoirs.

Other contentious land management issues in the catchments include the clearance of vegetation for agriculture and unsustainable management of forests for deer and pig hunting. These activities can also have direct and indirect impacts on water availability and biodiversity within the catchments.

3. METHODOLOGICAL APPROACH

The analysis required consideration and valuation of various alternative land and water catchment management options in the upper rainfall catchments of the reservoirs (Figure 1). The Figure shows the approximate delineations of the rainfall catchment areas (i.e. the overall area within which all rainfall and groundwater flows into the two reservoirs). The study was only interested in these upper catchment areas, because this is where any land use activities affect the volume and quality of water in the reservoirs. Activities downstream of these catchments have no bearing on the quality and quantity of the reservoirs.

Water collected within the reservoirs is used downstream in multiple different ways. Water from Mare Longue is used for irrigation, hydropower and supplementing Mare aux Vacoas (via the aforementioned canal), while the latter reservoir supplies potable water to the population.

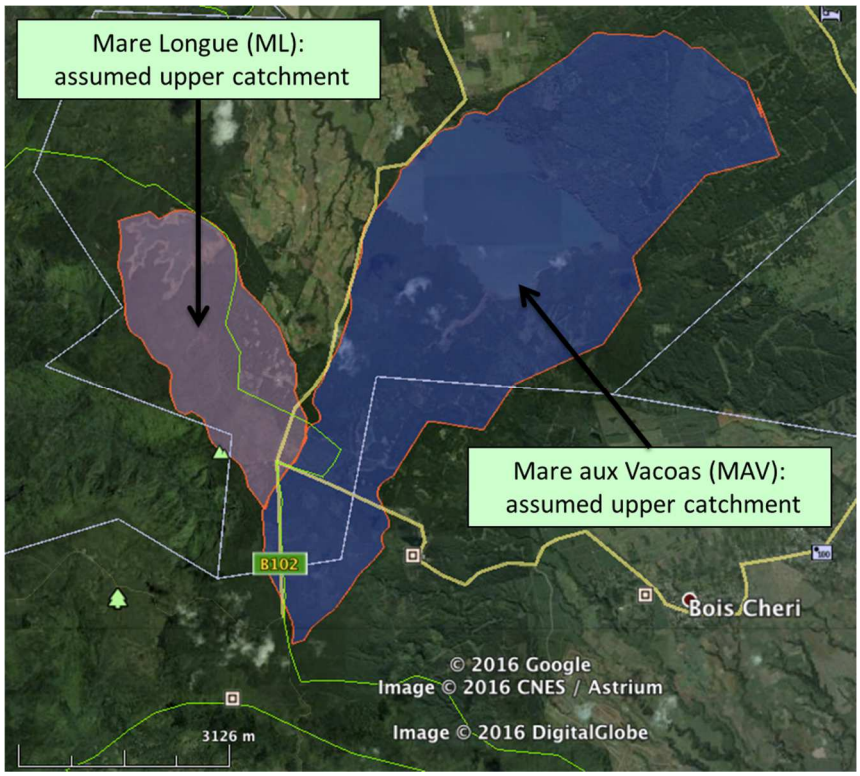


Figure 1: *Location of reservoirs showing assumed upper rainfall catchments*

A key study hypothesis is that alternative land management scenarios will result in a different mix of land cover with different associated evapotranspiration rates. This difference in water availability for

the reservoirs is a key issue to be quantified and valued in this assessment. Four different land use management scenarios are considered for each reservoir upper catchment. Each is briefly described in Table 1 below. The assessment covers a 25-year period for each scenario. Each scenario assumes the same current baseline and a straight-line change over 10 years to the projected scenario conditions (i.e. changing progressively by the same amount each year until year 10). The scenarios then each assumes a constant level for the remaining 15 years.

Table 1: *Description of scenarios for upper catchment management*

Scenario name	Brief description	Additional explanation
1) Do nothing	This is a purely hypothetical option representing what may happen if there is NO management at all and anyone can do what they want within the catchments.	This entirely hypothetical option is used simply as a reference point, which helps demonstrate the values of the current 'business as usual' scenario. It is literally a free for all, whereby any stakeholder could do anything they wanted, for example, cut down trees and plough up the land for agriculture.
2) Basic management (business as usual)	This is the most basic management option and comprises maintaining the current baseline conditions. It assumes some basic maintenance weeding of invasive plants (for Mare Longue), some limited 'alternate row harvesting' of pine trees and that all existing laws are adhered to.	This represents the current management situation for the sites. It involves basic management activities to maintain the different land use categories as they currently are (i.e. invasive plant and pine tree densities remain constant, similar level of hunting).
3) Proposed improved management	This is the proposed improved management already in place. It represents how things should look in the coming years.	This represents the current proposed, and slightly improved, management scenario. It would involve more control over invasive plants and some reduction in pine cover.
4) Ideal balanced management	This is the ideal balanced management scenario, where money is not a constraint. It balances conservation and other activities such as recreation and hunting.	This ideal management scenario would involve converting much of the pine tree cover to native vegetation, as well as intensive invasive weed control.

The first task was to map out the areas of the upper rainfall catchments for both reservoirs, with the support of the Central Water Authority. Then, using Google Earth and consulting both within the project team and with the Forestry Service, estimates of future land cover under each scenario were made. Given the lack of readily available information on each scenario, and the modest budget available for

the study, estimates for each land use were thus made based on professional judgement in accordance with the scenario descriptions in Table 1.

The following land use categories were deemed to be the most relevant:
- Pine forest – no invasive plants;
- Pine forest – with invasive plants (such as Chinese guava);
- Native forest – no invasive plants;
- Native forest – with invasive plants (such as Chinese guava);
- Grassland;
- Arable (crops);
- Road and buildings.

These land use types are likely to have different evapotranspiration rates that may affect the volume of water flowing into the reservoirs. Due to data and time constraints, surface run-off and groundwater flow rates under these land cover types were not assessed. Other factors such as soil structure which affects runoff could not be assessed. In addition, rainfall data for each catchment was not freely available so could not be accessed.

All scenarios are assumed to start off with the same baseline environment (i.e. same % land cover) as represented by Scenario 2 (Basic Management) in year 2016. For the purposes of this assessment, the land cover is then assumed to change in each scenario over a 10-year period to the percentage cover as set out in Tables 2 and 3 below.

Table 2: *Mare Longue scenario land cover assumptions*

Parameter	Today's baseline			Percentage cover under different management scenarios			
	Area (ha)	Current forest mix (100 %)	Percentage cover (%)	1) Do Nothing (%)	2) Basic mgmt (%)	3) Proposed improved mgmt (%)	4) Ideal balanced mgmt (%)
Forest	654.6		97%	55%	97%	97%	97%
Forest - Pine - no invasive plants	65.5	10%	9.7%	0%	9.7%	5%	5%
Forest - Pine - with invasive plants	261.8	40%	38.8%	25%	38.8%	12%	0%
Forest - Native - no invasive plants	65.5	10%	9.7%	0%	9.7%	50%	87%
Forest - Native - with invasive plants	261.8	40%	38.8%	30%	38.8%	30%	5%
Grassland & pasture	13.5		2%	10%	2%	2%	2%
Arable crops	-		0%	30%	0%	0%	0%
Urban and assoc development (road/houses)	6.7		1%	5%	1%	1%	1%
Total catchment upper run-off area	674.8		100%	100%	100%	100%	100%
Area of hunting (not mutually exclusive)	168.7		25%	40%	25%	0%	0%

Note: Area under arable crops is not zero but is negligible compared to other land uses

Table 3: *Mare aux Vacoas scenario land cover assumptions*

Parameter	Today's baseline			Percentage cover under different management scenarios			
	Area (ha)	Current forest mix (100 %)	Percentage cover (%)	1) Do Nothing (%)	2) Basic mgmt (%)	3) Proposed improved mgmt (%)	4) Ideal balanced mgmt (%)
Forest	2,514.7		95%	65%	95%	95%	95%
Forest - Pine - no invasive plants	553.2	22	21%	15%	21%	70%	50%
Forest - Pine - with invasive plants	1,886.0	75	71%	35%	71%	20%	10%
Forest - Native - no invasive plants	25.1	1	1%	1%	1%	3%	35%
Forest - Native - with invasive plants	50.3	2	2%	5%	2%	2%	0%
Grassland & pasture	105.9		4%	10%	4%	4%	4%
Arable crops	-		0%	30%	0%	0%	0%
Urban and assoc development (road/houses)	26.5		1%	5%	1%	1%	1%
Total catchment upper run-off area	2,647.0		100%	100%	100%	100%	100%
Area of hunting	926.5		35%	80%	35%	40%	40%

Note: Area under arable crops is not zero but is negligible compared to other land uses. It is possible that urban and other land uses may increase under Scenarios 2-4. For example, a wind farm is being planned for construction in the MAV catchment.

Key

Data from a referenced source
Data calculated from Google Earth
Guesstimate
Automatically filled

The land management options will also affect a range of other values. As part of this study, the following main values are assessed:

- **Water saved from reduced evapotranspiration:** This is assumed to be the cost-saving from not having to build additional infrastructure to obtain freshwater (or the value of water saved). The water savings are gained by reducing pine cover and invasive species cover which cause considerable additional evapo-transpiration compared to native vegetation and non-invasive plant cover.
- **Conservation (or non-use) values held by Mauritians:** This is the assumed willingness to pay value that some Mauritians (assumed to be 20%) may have for protecting some area of native forest in Mauritius not affected by invasive alien plant species.
- **Conservation (or non-use) values held by international visitors:** As for the previous value but for international visitors to the island (and assuming 25% are willing to pay).

- **Recreational value of Mauritians who visit the sites:** This is the value of additional enjoyment gained by local visitors from there being fewer invasive plants.
- **Recreational value of international visitors to the sites:** As for the previous value but for international visitors to the sites.
- **Hunting value:** The net value gained through hunting activities going on at the two sites (outside of the National Park boundary)[1].
- **Agriculture:** The net value (profit) gained from growing crops. Note that this only occurs in the assumed Do Nothing option where some forest is assumed to be cut down and converted to growing vegetables.
- **Carbon sequestration:** The societal value gained through carbon being sequestered by trees and invasive plants.

All associated assumptions used in the study are shown in Tables 4 to 7 below. Where applicable, reference sources are indicated. However, much of the information required is not readily available, so some assumptions and guesstimates have been made. Key stakeholders were given plenty of opportunity to challenge and improve the assumptions made during a lengthy consultation period following submission of the draft report.

It should also be noted that the main approach for monetary valuation has been that of 'value transfer'. This involves identifying values from other similar studies and making suitable adjustments to allow for differences in the context.

[1] Note that hunting lands have been blamed by some for deviating rivers and taking water that flowed into the Mare aux Vacoas, thus worsening the water scarcity in the catchment. However, this aspect has not been assessed within this study due to lack of data.

Table 4: *Generic assumptions for both reservoir catchments*

Topic	Parameter	Unit/value
	1 USD = in Rupee	35.5
	Discount factor	3%
Conservation	Mauritius adult population	1,220,000
	Proportion over 18 & potentially willing to pay	20%
	Adult population potentially willing to pay	244,000
	Mauritian adult assumed WTP for basic conservation (Rs/person/yr)	36
	Proportion of int visitors assumed WTP	25%
	International visitor assumed WTP for basic conservation (Rs/visitor)	71
Recreation visits	International visitors to Mauritius per year (2014)	1,040,000
	International visitor nights (2014)	11,270,000
	Total spend by tourists (Rs)	41,877,000,000
	Ave spend by Int tourists (Rs/person)	40,266
	Estimated visitors to National Park	350,000
Water	Value of water (Rs/m^3)	35.5
Agric	Value of agriculture (Rs/ha/yr)	3,550
Hunting	Overall area of hunting	1,099
	Number of hunting chassées	6
	Ave hunt days/chassée/year	8
	Ave fee per hunter paid to chassée	15,000
	Ave number hunters per trip	15
	Assumed profit	15%
	Value/year	1,620,000
	Value/ha/year	1,474
Carbon sequestration rate	Forest - Pine - no invasive plants (C tons/ha/yr)	6.0
	Forest - Pine - with invasive plants (C tons/ha/yr)	6.5
	Forest - Native - no invasive plants (C tons/ha/yr)	5.9
	Forest - Native - with invasive plants (C tons/ha/yr)	6.2
	Grassland & pasture (C tons/ha/yr)	6.0
	Arable crops (C tons/ha/yr)	0.5
	Value ton carbon	2,201
	Restoration costs (get native species back - Rs/ha)	400,000

Note: grassland and pasture in this context refers to mixed pasture and woodland systems found in Chassées, not cultivated pasture.

Key

Data from a referenced source
Guesstimate
Automatically filled

Table 5: *Visitor-related assumptions for the reservoirs*

Parameter	ML	Source	MAV	Source
Assumed % of Park visitors that visit the ML catchment	90%	Assumed	N/A	Assumed
Assumed proportion of people that visit MAV compared to visiting ML	N/A	N/A	50%	N/A
Total visitors	**315,000**	**Calc**	**157,500**	**Calc**
Assumed % Mauritian visitors	45%	Nat Park survey	80%	Nat Park survey
Assumed no. Mauritian visitors	141,750	Calc	126,000	Calc
Assumed % International visitors	55%	Nat Park survey	20%	Nat Park survey
Assumed no. International visitors	173,250	Calc	31,500	Calc
Ave WTP per Mauritian visit - for current experience	35.5	Assumed – from literature	18	Assumed – from literature
Ave WTP per Int visit - for current experience	100		50	

Note: Estimated numbers of visitors to both catchments are based on the estimate of 350,000 visitors per year for the Black River Gorges National Park. The ML estimate assumes 90% of the Park visitors visit the ML catchment (as the visitor centre is in the ML catchment), whilst the MAV estimate assumes there are only half as many visitors to the MAV catchment. The estimates include all people visiting or passing through each catchment – and not just those visiting the reservoirs.

Table 6: *ML Recreation and non-use value scenario adjustment factors*

Parameter	1) Do Nothing	2) Basic mgmt (current baseline)	3) Proposed improved mgmt	4) Alternative improved mgmt
Recreation - Visitor numbers - % of current numbers	75%	100%	110%	120%
Recreation - Visitor WTP - % of current amount	50%	100%	200%	300%
Non-use - WTP % of current amount	0%	100%	200%	300%

Note: The adjustment factors in this Table are based on professional judgement guesstimates only. The Basic Management estimate is the baseline figure of current estimated visitors. The other scenarios are based on an increase (>100%) or decrease (<100%) of the baseline estimates.

Table 7: *MAV Recreation and non-use value scenario adjustment factors*

Parameter	1) Do Nothing	2) Basic mgmt (current baseline)	3) Proposed improved mgmt	4) Alternative improved mgmt
Recreation - Visitor numbers - % of current	75%	100%	110%	120%
Recreation - Visitor WTP - % of current	50%	100%	150%	200%
Non-use - WTP % of current	0%	100%	150%	200%

Note: The adjustment factors in this Table are based on professional judgement guesstimates only. See note above regarding baseline estimate and other scenarios.

Key points regarding assumptions:

Water value: The value of water used in this study is based on an assumed value of Rs 35.5 per m^3 water (US$ 1 per m^3), which compares to the value of water in other countries such as the UK. However, it is worth noting that the average consumer surplus value of water for households in Mauritius as determined by Sultan and Peero (2015) is estimated to be Rs 200 per m^3 (i.e. 5.6 times as much). They

also estimate that the average marginal productivity[2] value of water for commercial use is Rs 1,413/m^3, with water for food valued at Rs 195/m^3 and water for electricity valued at Rs 1,938/m^3.

To determine a more accurate actual societal value of water for the reservoirs would require complex calculations based on the value generated by each of the different uses the water is put to, or through undertaking willingness to pay surveys of different consumer groups for it. A perhaps better alternative proxy value to use would be the cost of providing additional water for potable consumption. This could be estimated based on the overall average cost (including construction, operation and environmental costs) associated with gaining additional water capacity on Mauritius.

According to CWA Annual Report for 2014 (CWA 2015), the average price of water for consumers in 2014 was Rs 13/m^3 (US$ 0.37/m^3), although the cost of providing water was higher (but not specified). The CWA did request to government that the price is increased by 35%, but the increase did not materialise. It is interesting to note that bottled water in Mauritius costs around Rs 15 per litre, (i.e. RS 15,000/m^3 over 1000 times as expensive as tap water).

Evapo-transpiration rates: Evapo-transpiration rates have been taken from several references including Riekerk (1982), Huddle *et al*. (2011), Ford and Brooks (2003), Sumner (2001), McIntosh *et al.* (2010) and Nkemdirim (1973). The assumptions are included in Annex 2.

*Water value = hectares of land per land use type * m^3 /yr water lost by evapo-transpiration by land use type/ha * Rs 35.50/m^3 water. Note that this value is based on the difference between losses of water under the different scenarios.*

Visitor and conservation values: Several studies have helped inform the estimates of value used in this study (i.e. Rs 35 for Mauritian visitors to the Park, and Rs 100 for international visitors, with half those amounts assumed for visits to the Mare aux Vacoas). The values used in this study are thus considered relatively conservative in comparison. These studies are:

– The draft Black River Gorges National Park Management Plan 2017-2021 reports briefly on a questionnaire survey undertaken in 2014 by park rangers that asked Mauritians and international visitors whether they would be willing to pay a fee to enter the Black Gorges National Park. Details presented on the actual willingness to pay responses are limited: i.e. 53% of Mauritians would not be willing to pay[3], and 19% of international visitors would be willing to pay Rs 125 (around US$ 3.50)

[2] In economics, the term "marginal productivity" refers to the extra output gained by adding one unit of an input; all other inputs being held constant.

[3] The report does not state the amount that Mauritian visitors would be willing to pay.

to enter the park. It is important to note that the actual questionnaire has not been seen, so the reliability of these numbers is not known. Poorly designed, implemented and analysed willingness to pay surveys can yield highly inaccurate results.

- Sobhee (2008) determined that international visitors to Mauritius have a consumer surplus value of US$38 (Rs 1,350) that they would be willing to contribute to a conservation fund.
- Adams *et al*. (2010) established that resident visitors to parks in Florida were willing to pay an additional US$ 10 (Rs 355) per visit for more native plants and less invasive plants. However, it is important to recognise the difference in disposable income, and levels of education and environmental awareness between residents in Florida and Mauritius. This is why values that are 10 and 20 times lower, for ML and MAV respectively, are used for this study.
- Mwebaze *et al.* (2010) undertook a stated preference study in the Seychelles that determined average willingness to pay (WTP) values of US$48 (Rs 1,700) and US$42 (Rs 1,450) held by visitors for protecting turtles and the Seychelles Magpie Robin from the threat of invasive alien species. Again, these values are significantly higher than those assumed in this study.

*Conservation Value = visitor numbers (internationals) or population (Mauritians) * % assumed willing to pay * assumed willingness to pay value (Rs/person/year).*

*Recreation value = visitors * assumed willingness to pay (Rs/visit)*

Hunting: Hunting data for the sites was provided by the Forestry Service. Total areas, numbers of hunts per year, number of people and prices per person were provided. A guestimate has been made as per the profit margin (assumed at 15%). An average value per ha was then determined and used for the scenarios.

Hunting value = Total catchment area * % assumed hunting area * hunting land value (Rs/ha) per year

Hunting land[4] value (Rs/ha/year = Total hunting value per yr / area of hunting (ha)

Where hunting land value = Number of hunting grounds[5] * average hunt days/hunting ground/year * average fee per hunter * average number of hunters per trip

Agriculture: The value of agricultural land is simply based on an assumed net profit of around US$ 100/ha or Rs 3,550 per ha (i.e. US$ 50 per ha).

Agricultural value = agricultural land (ha) * average value/ha agriculture (i.e. Rs 3,350).

[4] Hunting grounds in Mauritius are known as chassées.

Carbon sequestration: Carbon sequestration rates have been guesstimated for the different land covers. Note that pine trees are assumed to have a slightly higher carbon sequestration rate than native trees, although the native trees have a lower water evapotranspiration rate and a higher biodiversity and recreation value. Where invasive plants are also present, the carbon sequestration rate is assumed to be higher.

Carbon sequestration value = area of land by vegetation type * carbon sequestration rate per vegetation type/year * Rs cost of carbon.

4. RESULTS

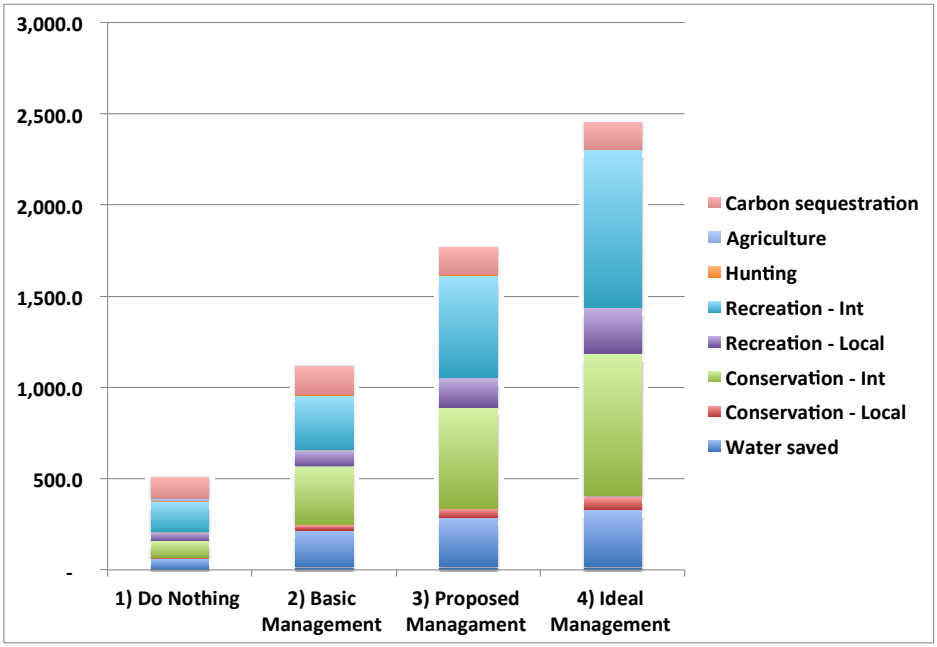
The analysis for **Mare Longue** indicates that Scenarios 2, 3 and 4 would generate total benefits of Rs 1.1 billion, Rs 1.8 billion and Rs 2.5 billion respectively (see Table 8). The values are based on the above assumptions aggregated over a 25-year period and discounted at 3%. Compared to the 'Basic Management' option, a Do Nothing option would generate less than half (46%) of the benefits, at Rs 0.5 billion. The 'Proposed Improved Management' would generate around Rs 650 million more (58% more) than 'Basic Management', and the 'Ideal Balanced Management' would generate around Rs 1,340 million more (i.e. over double) than the Basic Management option.

Table 8: *Mare Longue present value benefits for each scenario (in Rs Million)*

Parameter	1) Do Nothing	2) Basic Management	3) Proposed Management	4) Ideal Management
Water saved	61.5	218.7	287.4	331.3
Conservation - Local	8.5	30.2	51.8	73.5
Conservation - Int	90.4	321.4	552.5	783.5
Recreation - Local	48.3	87.6	163.2	251.4
Recreation - Int	166.2	301.7	561.8	865.4
Hunting	6.2	4.3	1.2	1.2
Agriculture	9.0	0.0	0.0	0.0
Carbon sequestration	123.8	160.4	156.8	154.1
TOTAL	513.9	1,124.3	1,774.8	2,460.4
Benefit compared to basic management	**-610**	**0**	**650**	**1,336**
% change compared to basic management	**46%**	**-**	**+58%**	**+119%**

Note: Total values generated over a 25-year period using a 3% discount rate.

Figure 2: *Mare Longue – Graphical breakdown of benefits*



Note that agriculture and hunting are minimal values and so are difficult to see in the graphs.

The breakdown for each scenario is also shown graphically in Figure 2. The bar charts clearly show how the conservation, recreation and water related values become significantly larger in each of the scenarios considered.

The relative proportions of each type of benefit for the Mare Longue scenarios are shown in terms of percentages in Table 9 below.

Table 9: *Mare Longue percentage benefit breakdown for each scenario*

Parameter	1) Do Nothing	2) Basic Management	3) Proposed Management	4) Ideal Management
Water saved	12.0	19.4	16.2	13.5
Conservation - Local	1.7	2.7	2.9	3.0
Conservation - Int	17.6	28.6	31.1	31.8
Recreation - Local	9.4	7.8	9.2	10.2
Recreation - Int	32.3	26.8	31.7	35.2
Hunting	1.2	0.4	0.1	0.0
Agriculture	1.7	0.0	0.0	0.0
Carbon sequestration	24.1	14.3	8.8	6.3
TOTAL	**100**	**100**	**100**	**100**

For **Mare aux Vacoas**, the results indicate that Scenarios 2, 3 and 4 generate a total value over of Rs 1.7 billion, Rs 2 billion and Rs 2.4 billion respectively (see Table 9). Again, the values are based on the above assumptions aggregated over a 25-year period and discounted at 3%. Compared to the 'Basic Management' option, a Do Nothing option would generate around half (51%) of the benefits, at Rs 0.9 billion. The 'Proposed Improved Management' would generate around Rs 317 million more (18% more)

than 'Basic Management', and the 'Ideal Balanced Management' would generate around Rs 660 million more (around 38% more) than the Basic Management option.

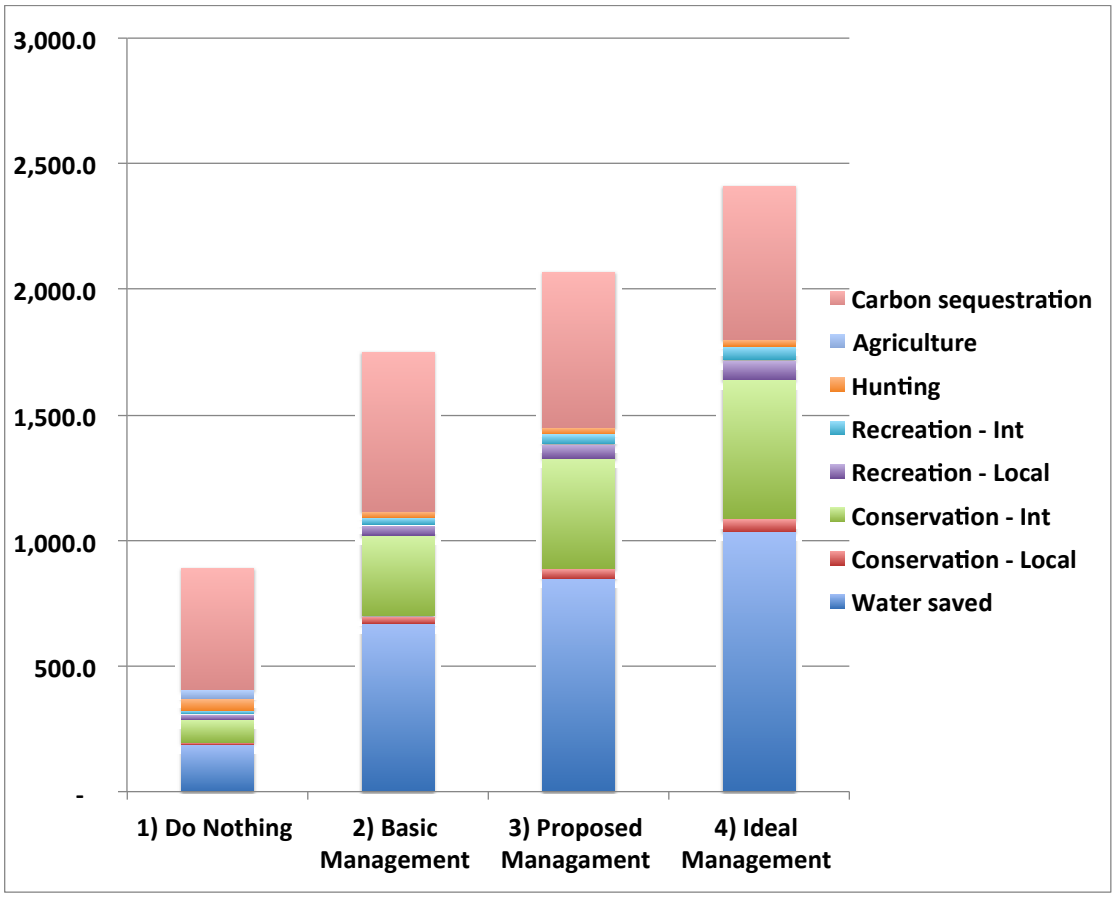
Table 10: *Mare aux Vacoas present value benefits for each scenario (in Rs Million)*

Parameter	1) Do Nothing	2) Basic management	3) Proposed management	4) Ideal management
Water saved	188.4	669.5	848.6	1,035.6
Conservation - non-use - Mauritian	8.5	30.2	41.0	51.8
Conservation - non-use – International	90.4	321.4	436.9	552.5
Recreation - Mauritian	22.8	43.8	58.5	79.5
Recreation - International	15.1	27.4	40.2	55.0
Hunting	45.8	23.8	26.2	26.2
Agriculture	35.3	0.0	0.0	0.0
Carbon sequestration	488.4	639.0	620.2	614.0
TOTAL	895	1,755	2,072	2,415
Benefit compared to basic management	-860	-	317	659
% change compared to basic management	**51%**	**-**	**+18%**	**-138%**

Note: Total values generated over a 25-year period using a 3% discount rate.

The breakdown for each Mare aux Vacoas scenario is also shown graphically in Figure 3 below. The bar charts clearly show how the water savings and international conservation (non-use) values become significantly larger in each of the scenarios considered, whilst the carbon sequestration does not change by much.

Figure 3: *Mare aux Vacoas – Graphical breakdown of benefits*



The relative proportion of each type of benefit for each Mare aux Vacoas scenario is shown in terms of percentages in the Table 11 below. In these scenarios, potential water savings from land management options are by far the most significant. This ranges from 38% to 43% of overall benefits by reducing pine tree cover and invasive plant species cover, both of which have a high evapo-transpiration rate. The international conservation (non-use) value is also a significant benefit gained through the more pro-active management scenarios. However, the table also clearly shows the trade-off between increasing both water savings and conservation value, and reducing the carbon sequestration value. However, overall that trade-off is worth-while due to the total additional societal value generated,

Table 11: *Mare aux Vacoas percentage benefit breakdown for each scenario*

Parameter	1) Do Nothing	2) Basic Management	3) Proposed Management	4) Ideal Management
Water saved	21.1	38.1	41.0	42.9
Conservation - Local	0.9	1.7	2.0	2.1
Conservation - Int	10.1	18.3	21.1	22.9
Recreation - Local	2.6	2.5	2.8	3.3
Recreation - Int	1.7	1.6	1.9	2.3
Hunting	5.1	1.4	1.3	1.1
Agriculture	3.9	0.0	0.0	0.0
Carbon sequestration	54.6	36.4	29.9	25.4
TOTAL	**100**	**100**	**100**	**100**

5. WHAT THE RESULTS MEAN

The results suggest that significant economic benefits to society can be gained through improved management of the reservoir catchment areas. The benefits would arise as a result of increased water availability (from reduced evapo-transpiration) and enhanced biodiversity due to reducing pine tree cover and invasive plant densities, and increasing native vegetation cover. The latter biodiversity improvements would potentially significantly benefit local and international site visitors as well as the general Mauritian population and international visitors to the island.

Table 12 shows the outcome of a high level 'distributional analysis' that identifies who the beneficiaries (i.e. stakeholder groups that benefit) would be from improving land management within the two catchments. The table not only identifies who the beneficiaries associated with each type of value are, but it also indicates potential ways that the values can be appropriated. Appropriating value in this case means potentially capturing the value through some means of monetary payment rather than simply the values accruing through improved individual well-being.

Table 12: *Improved catchment management beneficiaries and mechanisms to capture value*

Parameter	Who benefits?	Potential for capturing such values
Water saved from reduced evapo-transpiration	CWA will be the main beneficiary from the additional water saved under the different options. In theory, this would allow them to capture and treat less water elsewhere, or delay the provision of an additional water source.	CWA could increase the amount it charges water consumers, and part of that could be contributed towards the Forestry Service and National Parks and Conservation Service for habitat restoration of the catchment areas.
Conservation (or non-use) values held by Mauritians	These are values held by the people of Mauritius. However, this value would be significantly enhanced by informing the population about the importance of native biodiversity and the threats of invasive species.	These values can be captured to an extent through wildlife charities (e.g. the Mauritian Wildlife Foundation) and establishing 'Friends of Parks' type organisations and funds. However, the latter need to be well organised, transparent and effective to work. Tourist taxes are also an option for obtaining money from tourists for conservation activities. Such an approach is possible, but would require careful implementation and excellent associated awareness raising and publicity too. It should be noted that there already is a 'green tax', although the revenues do not go towards greening the island. In addition, the hotel sector is also averse to additional taxation as it threatens the competitiveness of the island compared to alternative locations.
Conservation (or non-use) values held by international visitors	These are the values in theory held by international visitors to the Island, but again, would be significantly enhanced by informing the population about the importance of native biodiversity and the threats of invasive species.	
Recreational value of Mauritians who visit the sites	These are values gained by Mauritian visitors to the site, but these too would be significantly enhanced by educating visitors as to the importance of native biodiversity and the threats of invasive species.	Visitor charges can be implemented through mechanisms such as car parks charges and entrance fees[6]. If visitors believe that the money they contribute will be well spent, they are far more willing to pay. Introducing such a policy can be contentious, but there are an increasing number of great examples in which such charges have been successfully introduced in other places around the world.
Recreational value of international visitors	As above, but are values gained by international visitors to the sites.	
Hunting values	These are values gained by both those people hunting (mainly wealthy Mauritians, but also some tourists) as well as the hunting owners	Hunting owners already pay licence fees – it is possible that these could be increased, but this

[6] As highlighted earlier in this report, a willingness to pay questionnaire survey was conducted at the Black River Gorges National Park. The results (detailed above) suggested that some Mauritians and international visitors were willing to pay an entry fee – but that this was not the majority. However, as already noted, for the resulting numbers to be reliable, it is important to understand how well the questionnaire was designed, implemented and analysed. If done inappropriately, the results could suggest an entirely incorrect outcome (i.e. that actual willingness to pay an entry fee could be much higher or lower).

Parameter	Who benefits?	Potential for capturing such values
	and employees. In addition to this recreational/cultural value, there is considerable value gained through selling the meat that is greatly appreciated by Mauritians and tourists, at home, in hotels and in restaurants.	would have to be carefully investigated and discussed with relevant stakeholders.
Agriculture	This activity does not currently occur in the catchments, but could, in theory, occur under a Do Nothing scenario. In such a case, it would potentially involve local people who may want to grow and harvest the crops, having cleared the land beforehand.	This is not seen as an activity to encourage or allow in the upper catchments.
Carbon sequestration	The global community as each ton of carbon sequestered potentially reduces the risks associated with global climate change. In this specific situation, this benefit tends to increase as other benefits decline, as it is enhanced by invasive plant species.	Various international mechanisms exist to gain credits from activities that increase carbon sequestration – however, none are considered appropriate in this context (i.e. through replacing pines with native trees, or from clearing invasive plants). In addition, Small Island Developing States (SIDS) do not easily attract carbon credit funding.

In addition to the welfare benefits generated by the outcomes of each scenario, scenarios 3 and 4 in particular would directly result in a significant number of jobs for local people to help clear the invasive species and plant native species. Furthermore, these scenarios, if well managed and promoted could lead to relatively significant additional employment through enhanced visitors and associated spending. This could particularly be the case if additional related eco-tourism activities were provided (e.g. guided tours). This would build on the native forest restoration work being currently undertaken by the NPCS, for example in the Black River Gorges National Park, and the gradual replacement of pine by the planting of native trees undertaken by the Forestry Service, for example in Plaine Sophie.

A key overall conclusion is that CWA could potentially charge consumers more for consuming water, with part of that revenue being invested back into management of the pine trees and invasive plants in the two catchments. Greater consideration should also be given to exploring practical and agreeable ways of 'appropriating' or capturing the conservation values of Mauritians and international visitors. This could be both those that visit the site (for example through introducing entrance fees) or for non-users through other means (for example through proactively promoting donations or 'friends of' type mechanisms).

6. RECOMMENDATIONS IN THE CONTEXT OF THE 2017 NATIONAL BIODIVERSITY STRATEGY AND ACTION PLAN

First, it is important to realise that "Proposed Improved Management" and "Ideal Balanced Management" scenarios would significantly contribute to the 2017 National Biodiversity Strategy and Action plan for the Republic of Mauritius. Indeed, progressively replacing pine trees with native species (forestry lands) and restoring ecosystem integrity (forestry lands and national park properties) would contribute to Strategic Goals B, which aims to reduce the direct pressures on biodiversity and promote sustainable use, and D, which aims to enhance the benefits to all from biodiversity and ecosystem services. More specifically, the following Aichi Targets would be further supported:

- **Aichi Target 7:** By 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity;
- **Aichi Target 9:** By 2020, invasive alien species and pathways are identified and prioritised, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment;
- **Aichi Target 14:** By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, considering the needs of women, indigenous and local communities, and the poor and vulnerable
- **Aichi Target 15:** By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.

Besides the expected water, recreation and conservation benefits, lobbying relevant stakeholders to invest in new niche eco-tourism opportunities throughout the catchment areas could lead to much needed diversification of the tourism industry to increase its attractiveness.

Second, Aichi Target 2 states that, by 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems. Based on the results of this study, it appears important that the proposed national water accounts (Weber, 2011) should further classify land-habitats into pine and native forests, showing their implications for evapo-transpiration and biodiversity conservation. Such accounts should also include the amount of land in important water catchments with invasive plant species cover. This would be instrumental to improve the monitoring of progress or performance against various Aichi Targets.

Finally, this pilot study presents an important example of how economic valuation, coupled to natural capital accounting, can help improve land / water use decision-making. By developing and regularly monitoring precise natural capital / ecosystem accounts (water, carbon, biodiversity / habitat integrity),

the Republic of Mauritius will be able to develop credible and reliable scenarios of change to explore alternative land use options, the expected costs and benefits for targeted or impacted stakeholders and the associated budget requirements.

Whilst this study has shown how a natural capital valuation approach can be used to help inform and justify land management decisions, it is based on some key assumptions. It is therefore recommended that additional research be undertaken to gain a better understanding and improved accuracy around some of the key assumptions. In particular, this includes further investigations relating to assumed: site visitor numbers, willingness to pay values, evapotranspiration rates and carbon sequestration rates.

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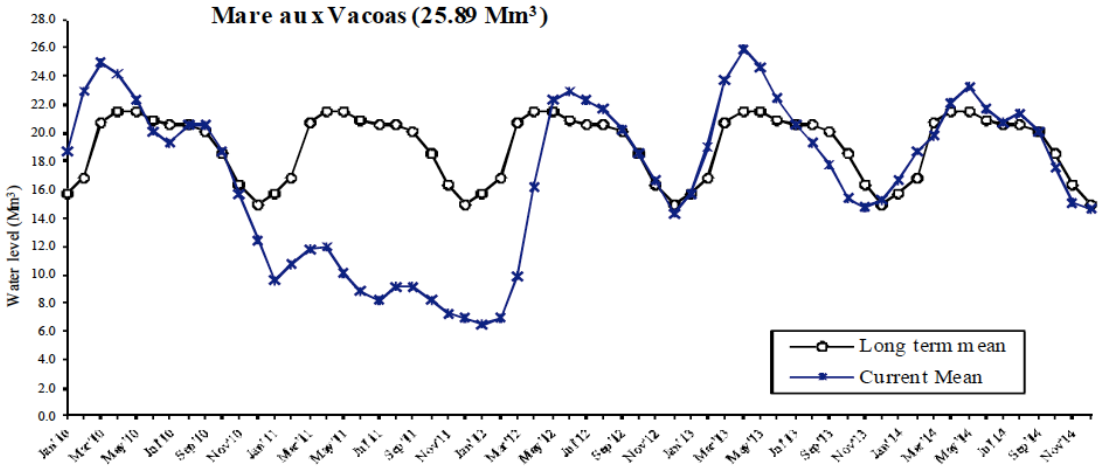
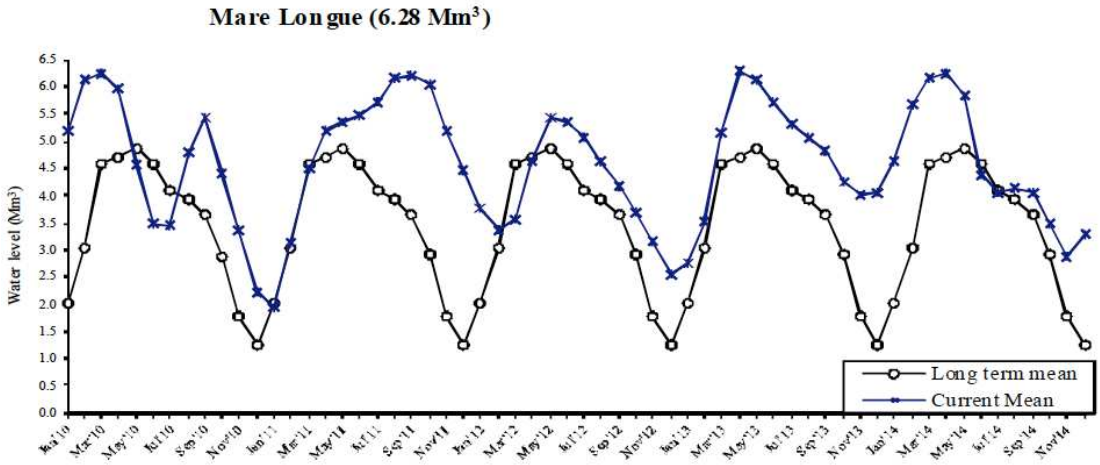
ANNEX 1 - WATER LEVELS IN THE TWO RESERVOIRS





Source: (Statistics Mauritius, 2015).

ANNEX 2 – ASSUMED EVAPOTRANSPIRATION RATES AND VOLUMES

Mare Longue - Evapo-transpiration loss under different scenarios

Land use	Evapo-transpiration rate (mm/yr)	Evapo-transpiration rate (m3/yr)	Do Nothing (m3 lost/yr)	Basic management & business as usual (m3 lost/yr)	Proposed improved management (m3 lost/yr)	Alternative improved management (m3 lost/yr)
Forest - Pine - no invasive plants	1,400	1.40	-	91,643	47,239	47,239
Forest - Pine - with invasive plants	1,680	1.68	283,432	439,887	136,048	-
Forest - Native - no invasive plants	980	0.98	-	64,150	330,671	575,368
Forest - Native - with invasive plants	1,230	1.23	249,016	322,060	249,016	41,503
Grassland & pasture	1,095	1.10	73,895	14,779	14,779	14,779
Arable crops	3,285	3.29	665,054	-	-	-
Urban and assoc development (road/houses)	550	0.55	18,558	3,712	3,712	3,712
Total			1,289,954	936,231	781,463	682,599
		Water saved (m3) compared to Do nothing	-	353,724	508,491	607,355
		Water saved(m3) compared to previous option			154,768	98,864

Mare aux Vacoas - Evapo-transpiration loss under different scenarios

Land use	Evapo-transpiration rate (mm/yr)	Evapo-transpiration rate (m3/yr)	Do Nothing (m3 lost/yr)	Basic management & business as usual (m3 lost/yr)	Proposed improved management (m3 lost/yr)	Alternative improved management (m3 lost/yr)
Forest - Pine - no invasive plants	1,400	1.40	555,871	774,514	2,594,066	1,852,905
Forest - Pine - with invasive plants	1,680	1.68	1,556,440	3,168,467	889,394	444,697
Forest - Native - no invasive plants	980	0.98	12,970	24,644	77,822	907,923
Forest - Native - with invasive plants	1,230	1.23	146,512	61,861	65,116	-
Grassland & pasture	1,095	1.10	289,847	115,939	115,939	115,939
Arable crops	3,285	3.29	2,608,625	-	-	-
Urban and assoc development (road/houses)	550	0.55	72,793	14,559	14,559	14,559
Total			5,243,058	4,159,983	3,756,896	3,336,022
		Water saved (m3) compared to Do nothing	-	1,083,076	1,486,162	1,907,036
		Water saved(m3) compared to previous option			403,086	420,874

Data from a referenced source
Data calculated from Google Earth
Guesstimate
Automatically filled

Increased evapotranspiration of native plants with invasives	26%
Assumed incr evapotranspration of pines with invasives	20%

REPUBLIC OF MAURITIUS

Ministry of Agro-Industry and Food Security

STUDY 3

Ecosystem-Based Adaptation strategies for a resilient Mauritian Protected Area Network

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Contents

Acronyms

AGB	Above-ground biomass
AF	Adaptation Fund
BGB	Below-ground biomass
CBD	Convention on Biological Diversity
CDM	Clean Development Mechanism
CEPF	Critical Ecosystem Partnership Fund
EbA	Ecosystem-based Adaptation
ESA	Environmentally Sensitive Areas
FS	Forestry Service
GCF	Green Climate Fund
GEF	Global Environment Facility
GHG	Greenhouse Gases
GIS	Geographic information systems
GoM	Government of Mauritius
ha	Hectare
IAS	Invasive Alien Species
INDC	Intended Nationally determined contributions
IOC	Indian Ocean Commission
IUCN	International Union for Conservation of Nature
JICA	Japan International Cooperation Agency
LMTF	Le Morne Heritage Trust Fund
LPA	Land Protected Area
MAC	Ministry of Arts and Culture
MAIF	Ministry of Agro-Industry and Fisheries
MAIFS	Ministry of Agro Industry and Food Security
METT	Management Effectiveness Tracking Tool
MESD	Ministry of Environment and Sustainable Development (former name of MSSNSESD)
MESDDBM	Ministry of Environment, Sustainable Development, and Disaster and Beach Management (former name of MSSNSESD)
MP	Marine Park
MPA	Marine Protected Area
MSSNSESD	Ministry of Social Security, National Solidarity and Environment and Sustainable Development
MWF	Mauritian Wildlife Foundation
NBSAP	National Biodiversity Strategy and Action Plan
NCCAPF	National Climate Change Adaptation Policy Framework
NGO	Non-governmental organisation
NHF	National Heritage Fund
NPCS	National Park and Conservation Service
PA	Protected area
PAN	Protected Area Network
PANES	Protected Area Network Expansion Strategy
PES	Payment for Ecosystem Services
REDD+	Reduced Emissions from avoided Deforestation and forest Degradation
SCP	Sustainable Consumption and Production
TEC	Technology Executive Committee (to the UNFCCC)
ToRs	Terms of reference
TNC	Third National Communication (Climate Change)

TT	Technology transfer
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WWF	World Wildlife Fund

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Executive Summary

Healthy ecosystems play an important role in delivering economic, social and environmental services to the Mauritian people and economy. Ecosystem-based adaptation (EbA), the use of biodiversity and ecosystem services as part of a strategy to help people to adapt to the adverse effects of climate change, are critical for improving the sustainability and resilience of the Mauritius' terrestrial and marine Protected Area Network (PAN). There is strong evidence of the need for EbA strategies throughout Mauritius (e.g. restoring forest ecosystems for more secure water supply for agricultural and other productive uses and restoring mangroves for coastal and lagoon protection). This study aimed to propose EbA strategies for improving the sustainability and resilience of the PAN to the impacts of climate change. Because of resource constraints the main focus is on the terrestrial PAN but challenges and opportunities for other ecosystems are touched upon.

The country's ecosystems of key biodiversity importance include forests that are supportive to both mitigation (net carbon sink) and adaptation (maximising the sustainable use of ecosystem services) strategies. The main agricultural ecosystems in Mauritius are cropland and grassland. Cropland is categorised into sugar and non-sugar crops while grasslands are used for livestock. Agriculture is both a victim and a driver of climate change. Marine and coastal ecosystems include mangroves, coral reefs and estuaries. These ecosystems supply people with multiple ecosystem services for livelihoods, economic development and protection against natural disasters.

The policy context for climate change adaptation includes key government strategies and policies in place to tackle climate change in various sectors. The study synthesises these policy provisions including and relates them to Mauritius' biodiversity.

The study assesses carbon dioxide sequestration of the current, planned and potential land-based PAN for Mauritius. It is estimated that expanding the formally protected area network from approximately 4% to 16% of the country's land surface area help secure carbon sequestration functions. Marine protected areas (MPAs) can also play an important role in carbon sequestration but assessment methodologies for MPA are still under development so the only part of an MPA that was assessed was that containing above-ground vegetation, such as the islets.

These estimates highlight the carbon sink role of the current and planned PAN in Mauritius but they are not precise estimates as no direct carbon stock assessments have been performed for different types of forests, no carbon stock monitoring has taken place on the ground to date, and there is very limited understanding of the different carbon sequestration rates of different species in Mauritius, though one could suppose that many long-lived indigenous species may hold bigger carbon stocks, for longer periods of time, than quick growing, yet relatively short-lived species such as pine trees.

The study outlines EbA challenges and opportunities for the Mauritius PAN, including cost uncertainties and potential sources of funding support. The study also outlines key enabling institutional conditions required for effectively implementing the proposed EbA strategies.

There are a number of EbA opportunities and challenges for enhancing the resilience of the PAN. First and foremost, most of the PAN is degraded by past land uses and invasive alien species (IAS), with less than 2% of the remaining native vegetation cover in relatively good condition. The PAN in its present form is not representative of all habitat types in Mauritius and does not adequately protect all species and / or the critical habitats required to maintain the ecological integrity of Mauritius' ecosystems. Species and native habitat outside of the PAN remain under threat from both IAS and development pressures. Institutional overlap in the management of the various types of PA, as well as limited funding and skills, also hamper effective PA management.

This is why every effort should be made; (1) to significantly expand the formal PAN (Aichi Target 11), and (2) to restore its ecological integrity though active restoration work (i.e. not only invasive plant control) (Aichi Targets 11, 12, 14 and 15). However, there are many uncertainties regarding the latter, in terms of actual ecological targets for different ecosystems, the transition from exotic to native vegetation (potential GHG stock losses when clearing) and the associated costs to do so. While Mauritius could learn from many exemplary island case studies that exist throughout the world, the country is fortunate to host some examples of effective ecological integrity restoration: i.e. the work undertaken on Ile aux Aigrettes, Round Island and Mauritian and Rodrigues mainland restoration work, spearheaded by the Mauritian Wildlife Foundation (MWF), the National Parks and Conservation Service (NPCS), the Forestry Service (FS) and under private sector initiatives. These endeavours should be supported by assessing the ecological return on investment. Answering this question would go a long way in better understanding the spatial diversity of ecological integrity restoration costs in the various PAN ecosystems.

This is critical information given that there are thousands of hectares to restore (i.e. financial resource needs would probably amount to dozens of millions of USD for the entire PAN). To that end, active fundraising must be pursed. Certain measures have been implemented or are already in the pipeline. NGOs and the private sector are pioneering cost recovery efforts and there are plans to charge an entrance fee for the Black River Gorges National Park. Besides new ecotourism initiatives and attracting international donor funding for carbon sequestration (around 100,000 tonnes sequestered annually by PAN forests), national incentive schemes should be explored and implemented (e.g. payments for ecosystem services, dedicated ecological taxes, and biodiversity offset schemes).

1. INTRODUCTION

Two key concepts underpin this study: Ecosystem-based adaptation (EbA) and resilience.

Ecosystem-based adaptation (EbA) is the use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people to adapt to the adverse effects of climate change (Colls *et al*., 2009). In other words, as one of the possible elements of an overall adaptation strategy, EbA uses the sustainable management, conservation, and restoration of biodiversity and ecosystems to sequester and store carbon (e.g. healthy forests, wetlands and coastal ecosystems) while generating significant social, economic and cultural co-benefits.

Resilience is the capacity of a socio-ecological system to absorb or withstand perturbations and other stressors such that the system remains within the same regime, essentially maintaining its structure and functions. It describes the degree to which the system is capable of self-organisation, learning and adaptation (Holling 1973, Gunderson & Holling 2002).

1.1 Study aims and scope

This study aimed to propose EbA strategies for improving the sustainability and resilience of the Mauritian Protected Area Network (PAN) to the impacts of climate change. More specifically, it intended to propose:

- Costed options for terrestrial EbA to climate change;
- A simple set of strong economic and political messages for the incorporation of challenges and opportunities of EbA to climate change in PAN activities.

The activities included:

- Describing the impact of climate change on the functioning of ecosystem services, such as water and nutrient recycling, species refugee, among others, in a geographically-based manner;
- Identifying areas of particular importance for restoration in order to improve climate resilience, adaptation and mitigation;
- Identifying areas important for improving nature's ability to adapt to climate change, such as altitudinal gradients and conservation corridors;
- Identifying enabling conditions including policies, data, and capacities for effective implementation of the EbA strategy;
- Identifying areas of rich ecosystems including carbon sequestration and biodiversity richness in Mauritius Protected Area Network (PAN);
- Preparing specific inputs for Mauritius' set of biodiversity targets (in line with the global Aichi Targets), and recommendations for the country's new NBSAP.

1.2 Methodology and limitations

EbA is a relatively new concept for most stakeholders in Mauritius involved in the biodiversity sector, including government departments and NGOs. This meant that extracting information to effectively inform the ToRs of this study required innovative approaches that unpack and interpret various sources and forms of information. The study applied a mix of approaches to draw insights from available sources in formulating EbA recommendations for a more resilient PAN. The study reviewed available information on climate change impacts on ecosystems and adaptation in the Mauritian context, making use of semi-structured stakeholder interviews with key informants.

The first step involved the retrieval of existing information on Mauritius ecosystems types, their spatial extents, associated ecosystem services and their linkages to climate change. This was done through archival research involving retrieval and review of various documents on the protected area network, Government of Mauritius (GoM) environment / biodiversity / climate change strategies, plans and initiatives as well as research papers. More in-depth content analysis of the documents was undertaken to identify the vulnerability of various ecosystems to climate change and match these vulnerabilities with key adaptation needs and strategies drawn from existing literature, empirical cases and examples from other relevant contexts/countries. The in-depth review also identified key strategic actors including local, national and international partners on EbA and identified ways through which such partnerships can be and have been leveraged to increase the sustainability and resilience of the PAN.

The document analysis was triangulated with interviews with key strategic stakeholders/partners to map key resilience needs and critical parameters for a resilient PAN. The interviews were undertaken during a field visit in Mauritius between the 8th and 14th June 2016. The face-to-face in-depth interviews were undertaken with PA management agencies (NPCS, Forestry Service - FS, hunting companies, and other PA managers / users), stakeholders within the national climate change and environmental departments and associated development agencies. The discussions covered various issues, including areas that are important for biodiversity, ecosystem services and human wellbeing, the vulnerability of the ecosystems to climate change, additional anthropogenic pressures exacerbating these vulnerabilities and the steps or measures that are in place to promote EbA.

There are several different definitions of the Mauritius PAN which can lead to confusion. Firstly, there is that of the PAN Project ('Expanding coverage and strengthening management effectiveness of the protected area network on the island of Mauritius'), implemented by the GoM, under the aegis of the Ministry of Agro Industry and Food Security (MAIFS) and co-funded by the Global Environment Facility (GEF) through the United Nations Development Programme (UNDP). This project's exclusive focus is the terrestrial PAN of the island of Mauritius including its associated islets.

The PAN of the Republic of Mauritius also includes marine protected areas (MPAs) and covers Rodrigues as well as Mauritius. In this study, however, we focus on the terrestrial PAN of Mauritius and only. The role of MPAs in carbon sequestration is also examined but only that of the above-ground portions of marine protected areas.

Both the document reviews and expert / stakeholder interviews generated information and insights that subsequently informed quantitative ecological analysis of carbon stocks from the various PAN ecosystems (forests, mangroves, and wetlands). GIS mapping tools were used to project carbon stocks for various ecosystems. The quantitative modelling of carbon stocks informed the potential for adaptation synergies.

The main reference for the carbon sequestration assessment was the IPCC guidelines (2006) There is a series of equations used to estimate the carbon sequestered. The five main carbon pools (above-ground biomass-AGB, below-ground biomass – BGB, dead wood, litter, soil carbon) are assessed, but with some modifications, due to lack of data and time constraints under this project. We adopted a single factor for each land class that can reflect all of these. This single factor was derived from national greenhouse gas (GHG) inventories reported in the Third National Communications (TNC) on Climate Change (Republic of Mauritius 2016a).

The derivation of this factor involved dividing the total carbon sequestered (found in the TNC) for each land category by the respective area for each. This single factor thus obtained, allowed us to estimate the carbon sequestered within the different land categories, e.g. protected areas, for which surface areas were readily available. It was assumed that native and exotic forests have the same carbon sequestration ability.

To assess the carbon sequestration possibilities of potential versus actual PAs it was assumed that official protection and conservation activities would increase the potential for carbon sequestration as there will be, for example, less bare land, fewer disturbances, greater sylvicultural practices/afforestation, etc.

Related to the above, some key limitations were encountered:

- Lack of understanding of potential EbA activities by the different PAN management authorities;
- Lack of accurate quantitative information (i.e. no accurate baseline and in situ monitoring system in place in Mauritius) to make projections about changes in carbon stocks against management options;
- Very limited cost / benefit information was available about alternative EbA options: Costs were available only for invasive plant control, not for reaching specific ecological integrity and / or ecosystem service supply targets.

1.3 Study outline

The study is organised into six sections. Following this introduction, the second section provides a description of the ecosystems of key biodiversity importance, associated services and climate change impacts. The policy context for climate change adaptation is outlined in section three; this includes key government strategies and policies in place to tackle climate change in various sectors. The study synthesises these policy provisions including what they do and relates them to Mauritius' biodiversity. Section four presents the modelled carbon dioxide sequestration of the current, planned and potential Protected Area Network, based on the Protected Area Network Expansion Strategy (PANES) (MAIFS 2017a). Drawing on the policy context, stakeholder consultation and carbon dioxide sequestration modelling, the study discusses, in section five, EbA challenges and opportunities for the Mauritius PAN, including cost uncertainties and potential sources of funding support. The study also outlines in section 5.6 a set of key enabling institutional conditions required for effectively implementing the proposed EbA strategies for the PAN.

2. LINKS BETWEEN ECOSYSTEMS AND CLIMATE CHANGE IN MAURITIUS

Healthy ecosystems play an important role in delivering economic, social and environmental services to the Mauritian people and economy. In Mauritius, they underpin several economic activities and the associated livelihoods (e.g. agriculture, tourism and fisheries). Due to the country's geographical location and associated climatic setting, the island is particularly prone to climate change impacts, including extreme events. The main ecosystem types in Mauritius are natural forests, plantations, agro-ecosystems, wetlands, mangroves and marine systems (e.g. coral reefs). These occur in different areas, to varying extents, and are exposed to climate change in different ways and magnitudes.

Table 2.1: The main climate change-related impacts on the main ecosystem types in Mauritius

Ecosystem types	**Climate change-related impacts**				
	Sea level rise	Acidification	Extreme weather events	Invasive species	Anthropogenic pressure
Forest plantations		√	√	√	√
Natural forests			√	√	√
Agriculture ecosystems -Grassland			√		√
Agriculture ecosystems - Cropland			√		√
Wetlands	√			√	√
Marine (fisheries, mangroves and coral reefs)	√	√	√	√	√
Islets	√		√	√	√

This section outlines the current and anticipated impacts of climate change on the ecosystems of Mauritius, both in the short and long term, as well as indirect impacts through anthropogenic actions. Table 2.1 provides a summary of climate change impacts on various ecosystems.

2.1 Forest ecosystems and climate change

Forests make up around 25 % of the land in Mauritius (Forestry Service, 2014), though only 2% of the land of Mauritius is native forest[1]. Forests, both in Mauritius and Rodrigues, are inhabited by a diversity of indigenous flora and fauna, including 691 plant species in Mauritius and 150 in Rodrigues. Out of these, about one third are single island endemics and another one quarter are Mascarene endemics. The forests also provide habitats for bats, and several endemic bird and reptile species.

Specifically, the role of forest biodiversity in supporting adaptation has been underscored globally in the context of UNFCCC programmes, such as Reduced Emissions from avoided Deforestation and forest Degradation (REDD+) activities and projects. According to Statistics Mauritius (2016), the country emitted 3,969.6 thousand tonnes of GHGs in 2014, with electricity generation being the principal GHG emitter (Figure 2.2). It is critical to note that forest ecosystems remain the only net terrestrial sinks of carbon in the country, capturing about 367.5 thousand tonnes per year (Third National Communications (TNC) on Climate Change (Republic of Mauritius 2016a). In other words, about 11% of Mauritius' GHG emissions are captured by forests.

[1] As defined by Page and D'Argent (1997) where good condition is defined as forest with native canopy of greater than 50%.

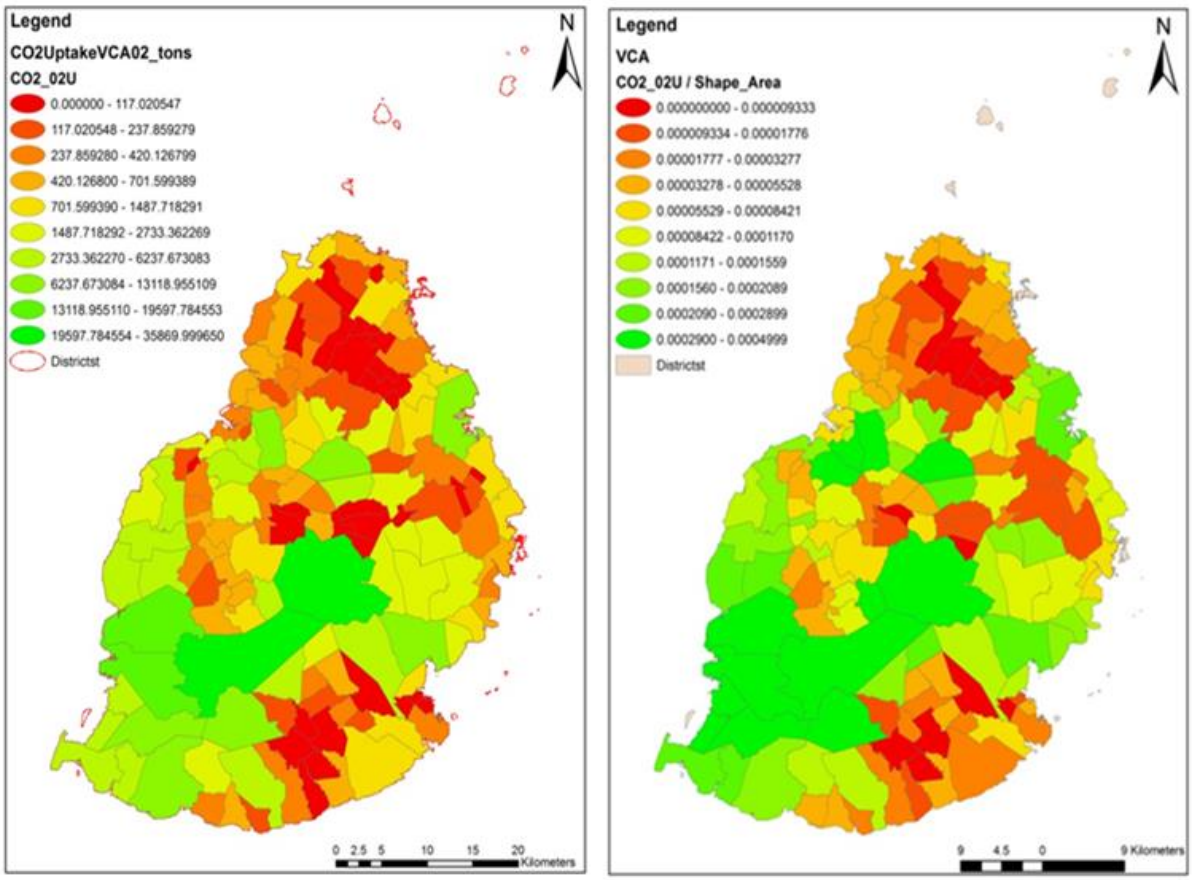

Figure 2.1: Carbon sequestered in Mauritius

Greener areas denoting increased sequestration

Choropleth maps for carbon sequestration for 2002. Left: total carbon sequestration, tonnes; right: carbon sequestered per unit area, ton per km^2 (Sookun *et al.*, 2014).

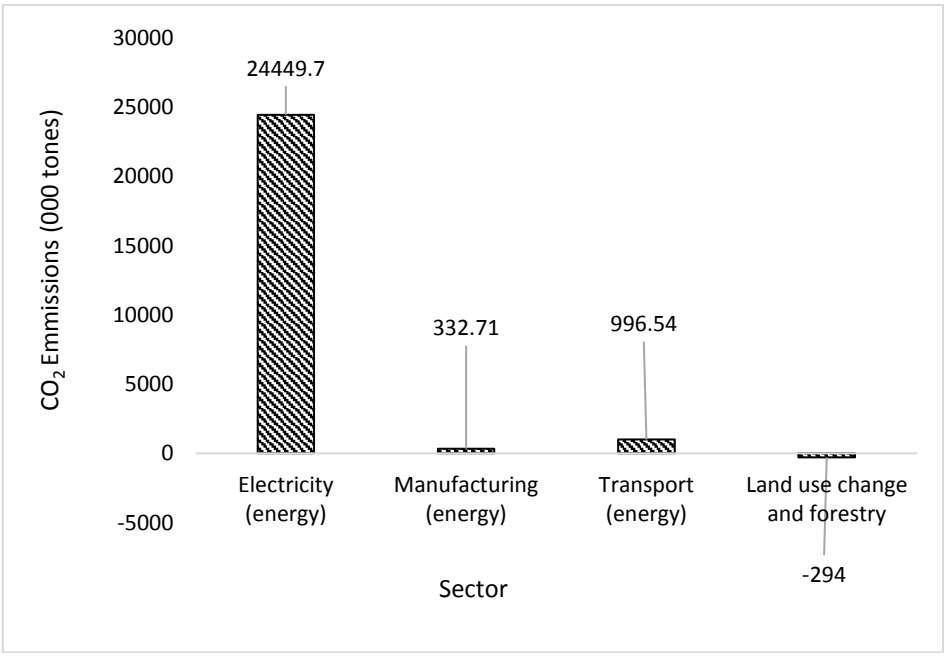

Figure 2.2: Annual CO_2 emissions by sector in Mauritius in 2014 (Statistics Mauritius 2016)

In addition, both natural forests and plantations supply many:

- Provisioning services, such as fruits, honey, timber and clean water resources;
- Regulatory services, such as carbon capture and storage for climate regulation, soil formation, erosion control, air pollution regulation, water storage and filtration, and flood control services; and
- Cultural ecosystem services, such as walking, hunting, hiking and birdwatching. activities, which help diversify the tourism offerings of Mauritius. Some protected areas, such as the Black River Gorges National Park, hold forests which are now key touristic sites, where both local and foreign tourists (MAIFS 2017b) pursue various activities such as walking, jogging, hiking, picnicking and even fruit gathering.

However, forest ecosystems are exposed to climate change-related impacts, including extreme weather events, invasive species and climate-driven anthropogenic pressures, which lead to species loss and habitat degradation:

- Climate change might be linked to the proliferation of invasive species, such as Chinese guava (*Psidium cattleianum*), which appear to be better adapted to changing climatic conditions and are thus able to outcompete native forest species.
- Climate change could also be linked to an increase in the number of dry days due to unpredicted rainfall patterns. This in turn could affect agricultural production, leading farmers to target unprotected forest areas with better moisture contexts.
- Extreme events, such as cyclones, lead to forest destruction: i.e. falling trees which then affects tree density, exposing various forest based flora and fauna to more shocks. Habitat destruction and modification weakens the resilience of forests to pests and diseases and future climatic disasters.

Overall, forest ecosystems are supportive to both mitigation (net carbon sink) and adaptation (maximising the sustainable use of ecosystem services) strategies. Because most forest ecosystems are within the potential PAN, PAN management agencies should collaborate to make sure forest management practices are in line with all Mauritius' CBD and UNFCCC commitments.

2.2 Agro-ecosystems and climate change

The main agricultural ecosystems in Mauritius are cropland and grassland. Cropland is mainly categorised into sugar and non-sugar crops (i.e. vegetables, fruit, medicinal plants) while grasslands are used primarily as livestock ranches. In Rodrigues, agricultural biodiversity is categorised into fruits and food crops (livestock and crop production).

Agriculture is both a victim and a driver of climate change. The impacts of climate change on agricultural systems relates mainly to extreme weather events, such as drought and excessive rainfall while agriculture can contribute to climate change by various means such as food processing which releases GHGs, the manufacture and application of agrochemicals, nitrous oxide emissions as an indirect product of nitrogenous fertilisers and methane produced by livestock. Mauritius has experienced changing rainfall patterns through a decreasing trend in annual rainfall since 2009. This decrease has been accompanied by increasing numbers of consecutive dry days and decreasing numbers of rainy days (Meteorological Services, 2009). The mean amount of rainfall around the Island of Mauritius was 2,094 millimetres (mm) in 2014 (GoM 2010). This can affect crop productivity as well as livestock production. To date, about 45% of the current Mauritius water budget is assigned to agriculture and out of this 75% is water rights assigned mainly to agricultural companies and irrigation schemes.

From 2009 to 2013, there was a general slowdown in the agricultural production of the Republic of Mauritius. Interviewed agricultural sector stakeholders expressed their views that climate change has resulted in more cold days and more warm nights, destabilising the sugarcane flowering calendar and thus affecting yields. In addition, climate impacts on agricultural biodiversity could manifest themselves through the loss of genetic resources, as important genetic resources may be affected by a drier climate or climate-induced anthropogenic pressures.

The changing rainfall patterns and resulting impacts are exacerbated by a lack of proper strategies to EbA that could enhance and restore available rainwater for sustainable use. From the National Statistics, Mauritius received about 3,905 million cubic meters (Mm^3) of rainwater with an estimated utilisation of 895 Mm^3 in 2014 (both surface and ground waters). This represents only 22% of the total rainwater received that year. Much of this water has been lost through lack of water retention and evapotranspiration, some of which is due to ecosystem degradation (e.g. deforestation and wetland degradation) and the general vulnerability of the ecosystem to climate change.

For agro-ecosystems, in the context of fulfilling both CBD and UNFCCC obligations, the role of EbA strategies for the PAN is potentially twofold:

- Improving the delivery of ecosystem services (e.g. clean, reliable water throughout the year, soil formation, erosion and flood control, pollination services, auxiliary species to fight pests, and reservoirs of genetic diversity for wild crop relatives) to agricultural producers and urban beneficiaries, and
- Providing incentives for agricultural producers and other land owners / lessees to contribute to the expansion of the PAN through active ecosystem restoration measures, beyond the

prevention of agricultural encroachment and towards restoring the ecological integrity of river corridors from mountain tops to the sea.

2.3 Marine and coastal ecosystems and climate change

Marine and coastal ecosystems range from mangroves, coral reefs, estuaries, and wetlands among others. These ecosystems supply people with multiple ecosystem services for livelihoods, economic development and protection against natural disasters. For instance, fisheries remain a major source of livelihood for many Mauritians living along the coastlines.

Mangroves and wetlands are key in establishing and protecting fresh water resources and provide many services: e.g. habitat for a wide diversity of plant and animal species including many commercially important fish species, shoreline stabilisation, storm protection, water storage, flood control, sediment and nutrient retention, carbon sink, aesthetic and educational opportunities. Clearance of mangroves results in sediments not being properly filtered leading to high rates of soil runoff into lagoon areas, increasing turbidity which affects overall lagoon productivity. Beaches and sand dunes are important habitats for coastal species and key recreational areas.

The main climate change-related threats to the freshwater, marine and coastal ecosystems are sea level rise, extreme events such as cyclones and storms, as well as climatically induced anthropogenic activities. Mauritius experiences a mean sea level rise of 1.2 mm per year and this is more severe in some parts (e.g. the Trou Fanfaron - Port Louis which over the last decade experienced a local mean sea level rise of 2.1 mm per year; GoM 2010). From a global perspective, a rise in sea level of 0.2 to 0.6 m or more by 2100 (IPCC 2007) could result in intense cyclones, frequent tidal surges and altered precipitation disruptive to coastal ecosystems, settlements and economic activities (e.g. tourism). Increased temperatures are likely to be associated with more frequent and extensive incidents of coral bleaching like that experienced by Mauritius in 2009.

Sea level rise is already inflicting detrimental effects on the coastal ecosystems (Ministry of Environment and Sustainable Development, 2011). Such impacts include erosion of the shoreline as well as inundation causing loss of coastal ecosystems. These impacts are further exacerbated by human induced pressures such as infrastructural development along the coast (increases in habitat loss and pollution).

Ocean acidification, the ongoing decrease in the pH of the Earth's oceans, caused by the uptake of CO_2 from the atmosphere and eutrophication are major climate-related threat to marine and coastal ecosystems. For instance, increasing CO_2 emissions contribute to ocean acidification, thus altering the relative population sizes of species, including those which cannot withstand changes in seawater chemistry and temperature (especially corals). For instance, cases of fish mortality were reported in

January 2009 at Poudre d'Or and attributed to sudden rise in the sea surface temperature (up to 31.5 °C). Increasing average sea surface temperature has also been linked to decrease in tuna catch in the Western Indian Ocean (Lan *et al.*, 2013). In fact, it is predicted that, as the El Niño phenomenon becomes more frequent, intense and of longer duration, the size and location of fish stocks and fish migration patterns will be affected (IPCC 2007).

For marine and coastal ecosystems, in the context of fulfilling both CBD and UNFCCC obligations, the role of EbA strategies for the PAN is potentially twofold:

- Improving the delivery ecosystem services (e.g. fisheries, coastal erosion prevention) to target beneficiaries (e.g. fishing, tourism and property development industries), and
- Providing incentives for property developers and all marine resource users to contribute to the PAN through active ecosystem restoration measures (beyond mere reduced harvesting pressures).

To conclude this section:

- Different ecosystems provide different services to the Mauritian economy. They are all under threat from climate change impacts, both direct (e.g. more frequent drought periods and cyclones) and indirect (e.g. anthropogenic pressures due to adaptation strategies).
- Extreme weather events and anthropogenic pressures are key sources of climate change impacts affecting all ecosystems. Acidification is an issue for marine ecosystems while forest ecosystems are particularly threatened by invasive alien species (IAS).
- To explore EbA strategies for the PAN, according to both CBD and UNFCCC obligations, it is important to note that:
- Many forest ecosystems are under the current PAN, though most of them are invaded by alien species and are thus highly degraded and in need of ecological integrity restoration.
- The PAN in marine and coastal ecosystems is more limited in surface area and is not covered under the PANES. Much potential exists for an integrated approach to catchment to sea ecosystem management.
- Agro-ecosystems need to be considered, both as source of potential threats to the PAN and as potential PAN expansion areas.

3. MAURITIUS POLICY CONTEXT FOR ADDRESSING CLIMATE CHANGE IMPACTS

To respond to climate change impacts on ecosystems and human wellbeing, the Government of Mauritius has put in place policy provisions and frameworks within which adaptation options can be pursued. This section first synthesises the existing climate change policy documents and associated information. The various key stakeholders and projects are then briefly presented.

3.1 Global and national policies

Before outlining options for EbA, it is important to understand the current institutional and policy landscape of Mauritius, including which measures have been put in place by the Government to respond to climate change. This understanding is critical to enable the development of strategies that align well with the existing national policies and institutions.

The GoM has supported the integration of climate change mitigation and adaptation measures into core polices, strategies and development processes since 1992. To date, the Government has put in place a relatively vibrant climate change institutional and policy framework within which EbA for the PAN can be achieved.

To begin with, Mauritius has committed to agreements at the international level and has also adopted various policies and strategies at the domestic level to conserve biodiversity, including some provisions for EbA.

At the global level, Mauritius is a member state to the **United Nations Framework Convention on Climate Change** (UNFCCC). The UNFCCC evolved from the 1992 United Nations Conference on Environment and Development (UNCED 1992). The UNCED meeting achieved a key milestone in the global fight against climate change by bringing together over 190 States to collectively commit to an international climate convention, the UNFCCC. The UNFCCC was established as a platform for States and non-State actors to negotiate ways of solving climate change threats in the context of sustainable development. Sustainable development in this case is defined as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'. Article 3.4 of the UNFCCC declares that climate change policies should aim to achieve sustainable development outcomes such as conservation, socioeconomic development and poverty alleviation in developing countries (UNFCCC 1992).

Through the UNFCCC, the international community has established mitigation and adaptation as means to addressing climate change. Mitigation involves anthropogenic interventions to reduce the

sources or enhance the sinks of GHGs. Adaptation refers to the adjustment in natural or human systems in response to climatic impacts in a manner that moderates harm or exploits beneficial opportunities. Both mitigation and adaptation are expected to achieve sustainable development by spatially and temporally harmonising socio-economic development with environmental conservation in a manner that safeguards the wellbeing of current and future generations. The UNFCCC talks have specifically achieved commitments on mitigation through negotiated policy instruments targeting markets for carbon credits. These GHG credits (in CO_2 equivalent) are to be traded between States and non-State Parties, thus enabling Parties to offset and maintain their emissions within allowable levels (Thomas and Twyman, 2005). Within the UNFCCC, Mauritius actively participates in high level international climate change negotiations and informs the process through the Alliance of Small Island States, the Africa Group and the Group of G77 and China.

The UNFCCC emphasises the need for countries to adopt EbA measures that enhance environmental resilience and food security. In line with this, the UNFCCC has outlined five key principles that can guide countries in preparing EbA strategies. These include sustainable water management, disaster risk reduction, smart agricultural systems and strategic management of ecosystems and protected area networks for the delivery of ecosystem services that increase resilience to climate change.

The **CBD Strategic Plan for Biodiversity 2011-2020**, that led to the establishment of the Aichi Biodiversity Targets, also highlighted the significance of EbA in enhancing biodiversity resilience in vulnerable countries. More specifically, Aichi Target 15 calls for countries, by 2020, to enhance ecosystem resilience and the contribution of biodiversity to carbon stocks, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification. In other words, the restoration of the ecological integrity of ecosystems is now recognised as a key tool for enhancing carbon stocks (e.g. though old growth natural forests) as part of an EbA strategy.

At the national level, the **Fifth CBD National Report for Mauritius** (MAIFS 2015) earmarks EbA to climate change as a priority for Mauritius biodiversity management. The report highlights some of the key adaptation options including building ecological resilience at landscape scale by protecting habitats and reducing anthropogenic pressures while increasing connectivity by establishing conservation linkages across the landscape and therefore facilitating the adaptation of species to climate change. Both the NBSAP and the Fifth CBD National Report for Mauritius identify the need to better account for, manage and plan for climate resilience and adaptation through the improvement of the status of ecosystems, species and genetic diversity in the country.

At the national level, Mauritius has enacted several climate change policies and plans. The **National Climate Change Action Plan** was developed in 1998 (Mauritius National Climate Committee 1998),

with details on sectoral responses for water resources, waste management, agriculture and forestry, fisheries, coastal zone management, energy planning and transportation. The plan also made provisions for national communication to the UNFCCC.

The **Mauritius National Biodiversity Strategy and Action Plan** (NBSAP; Ministry of Agro-Industry and Fisheries, 2005) is a ten-year plan on how to sustainable manage and conserve biodiversity in line with the CBD guidelines. The NBSAP 2006-2015 outlines key measures to be taken in conserving biodiversity. The report highlights some of the key adaptation options including building ecological resilience at landscape scale by protecting habitats and reducing anthropogenic pressures while increasing connectivity by establishing conservation linkages across the landscape and therefore facilitating the adaptation of species to climate change.

Mauritius has also prepared a **National Climate Change Adaptation Policy Framework** (NCCAPF, Republic of Mauritius 2013). The main goal of the framework is to mainstream climate change adaptation options into main development and conservation policies and strategies in key Mauritius' sectors such as water, agriculture, fisheries and tourism. The framework emphasises the role of EbA both for humans and biodiversity, particularly the need to protect existing native species and restore indigenous species of flora and fauna within both forests and aquatic ecosystems. It highlights a number of EbA options including conservation of endemic endangered reptiles of the Mauritian offshore islets, protection of the coastal zone and marine ecosystem, focusing initially on rehabilitation of damaged coral reef system through coral farming, creating sand banks for beach nourishment, developing specific biodiversity conservation and resilience plans including monitoring and managing the use of terrestrial and marine biodiversity to ensure that they continue to provide ecosystem services in a sustainable way.

The **NCCAPF** also envisages integrated water management including expanding setback adaptation levees and bypasses to enhance flow of flood water to support ground water recharge for infiltrations, enhance wetland restoration and promote increase green areas that could enhance carbon sequestration and enhancing protected ecosystem networks. Alongside these, the plan also emphasises the role of business incentives such as Payment for Ecosystem Services (PES) (e.g. water pricing, carbon trading which can play a role in supporting EbA).

The **Mauritius Technology Needs Assessment and Action Plan for an Enhanced Climate Change Adaptation and Mitigation** (Republic of Mauritius 2012) provides technology options and strategies to implement feasible technologies for climate change mitigation and adaptation in line with national development priorities. The plan identifies key priority technologies for supporting adaptation and mitigation in the water, agriculture, coastal marine and energy sectors. The key technologies identified for water include water harvesting and desalination while in agriculture and

forestry, reforestation, integrated pest management, irrigation and climate smart agricultural options are prioritised. For coastal and marine ecosystems, the plan emphasises the need to restore coastal vegetation, protect wetlands, restore dunes and rehabilitate coral reefs.

The Government of Mauritius has also prepared and submitted the **Intended Nationally determined contributions (INDC)** to the UNFCCC (Republic of Mauritius 2015). The GoM submitted the INDC in response to decisions adopted at the 19th and 20th sessions of the Conference of the Parties to the UNFCCC. The INDC outlines a set of voluntary adaptation and mitigation actions that Mauritius will undertake in response to climate change. A key element of the INDC is that it has been prepared in line with the socioeconomic circumstances of Mauritius and as part of the country's international climate commitment. The INDC proposes a number of adaptation options in key sectors including agriculture, water, fisheries, and infrastructure among others. The key adaptation measures proposed include climate smart agriculture and fisheries, irrigation, improving resilience of marine/coastal biodiversity through improvement of the management of marine and terrestrial protected areas and expansion of protected area network including rehabilitation of wetlands, seagrass, mangrove plantation, increase in tree coverage areas and coral reef rehabilitation/farming among others. The INDC also proposes a raft of mitigation options including climate smart agriculture, enhancing forest sinks and use of low carbon energy sources such as solar, wind among others. Furthermore, the INDC reiterates actions that will strengthen Mauritius' climate change institutional framework including transparency measures. A key point stressed in the Mauritius INDC is the fact that proposed mitigation and adaptation options should enhance more climate financial flows into the country for implementation.

The **Strategic Plan 2016-2020 for the Food Crop, Livestock and Forestry Sectors** (Republic of Mauritius 2016b), sets out the objectives to improve the level of food security and food safety and promote a more sustainable agriculture in Mauritius. It promotes capacity building to enable farmers to face climate change and move on to 'climate-smart agriculture'.

The **National Forestry Policy** (Republic of Mauritius 2006) emphasises the role of forests in mitigating the effects of climate change and in carbon sequestration and seeks to conduct research on the impact of climate change on forests.

Mauritius has also prepared a **Climate Change Bill**[2]. The Bill establishes the legal framework and mechanism for enhancing resilience of Mauritius livelihoods and ecosystems to the impacts of climate change. The Bill also regulates Mauritius' low carbon pathways and green economy

[2] http://www.govmu.org/English/News/Pages/A-Climate-Change-Bill-to-better-address-effects-of-climate-change-is-in-the-pipeline.aspx , accessed on December 16, 2016.

transitions. Drawing on the Bill, it is possible to develop appropriate, suitable, feasible policies and strategies EbA strategies for the PAN.

Also worth noting is the **Mauritius Environment Outlook** report prepared under the then-named Ministry of Environment and Sustainable Development (MESD), which highlights the policy choices for mitigation and adaptation among others (Republic of Mauritius 2011).

3.2 Mauritius' climate change agencies

The Ministry of Social Security, National Solidarity and Environment and Sustainable Development (MSSNSESD) is the focal point Ministry for the UNFCCC and its Kyoto Protocol. The Ministry is responsible for the coordination of the country's priorities on climate change, including EbA, national goals monitoring and international commitments taken by the Mauritius Government.

Within the Department of Environment at the MSSNSESD, there is a Climate Change Division which was established on the 1st of March 2010. Its mandate is to guide the implementation of international climate change agreements such as the UNFCCC, the Paris Agreement among others. The Division is also responsible for undertaking GHG inventories and for monitoring and implementing the national climate change adaptation plan and mitigation strategy. The Division also develops strategies for raising funds for climate actions and mainstreaming across key Mauritius sectors and development strategies.

Alongside this agency, the Mauritius Government Ministries are also required to play a prominent role in mainstreaming the climate change adaptation and mitigation in their respective programme areas.

3.3 Projects and interventions

The Government of Mauritius has put in place interventions and projects to translate the policies mentioned in section 3.1 into practical on-the-ground actions. These projects span regional, national to local dimensions, focus on different topics (including coastal and marine habitats, agro-ecosystems, biodiversity, fisheries, forests, etc.) and aim to address various types of shocks, including climate change.

The PAN Project is extremely relevant in this respect. One of the key outputs of the PAN Project is the PAN Expansion Strategy (PANES) (MAIFS 2017a). During the development of the PANES over the last two years, four major areas of competency were identified that need to be developed and institutionalised: Conservation planning, biodiversity stewardship, nature-based tourism development, and invasive alien species (IAS) management. These actions directly or indirectly

support adaptation and resilience of the biodiversity within the PAN. The main adaptation value under the PANES lies in the efforts to expand the PAN to protect remaining natural habitats from overexploitation / destruction and the drive towards ecological integrity restoration (i.e. mainly though IAS control and / or eradication). The PANES also supports conservation planning in a manner that enhances effective management of the ecosystem services including their linkages, landscapes and environmental flows across the various ecosystems, from forest catchments, agro-ecosystems to coastal and marine ecosystems (although marine areas are excluded from the PANES). Enhancing ecosystem integrity through proper planning and PA expansion is critical for promoting a symbiotic relationship between various ecosystems and land uses, thus enhancing the resilience of the PAN to external stresses.

Mauritius is undertaking a number of projects to increase the resilience of coastal areas including the lagoon. These include the Project for Capacity Development on Coastal Protection and Rehabilitation in the Republic of Mauritius with support from JICA – project goal - to prepare "Coastal Conservation Plan" which is approved and implemented by the Government of Mauritius, and; the UNDP/GEF Project, Mainstreaming biodiversity into the management of the coastal zone in the Republic of Mauritius – project objective, to mainstream the conservation and sustainable use of biodiversity and ecosystem services into coastal zone management and into the operations and policies of the tourism and physical development sectors in the Republic of Mauritius through a land- and seascape wide' integrated management approach based on the Environmentally Sensitive Areas' (ESAs) inventory and assessment.

The GoM is also engaged in the implementation of the **Clean Development Mechanism** (CDM) projects in the energy and forestry sectors. The Designated National Authority is the National CDM Office within the Department of Environment of the MSSNSESD. The National CDM Office was set up following a decision taken at the meeting of the Cabinet of Ministers in March 2003. The CDM Office was allocated the task of assessing potential CDM projects to determine whether they will assist the country in achieving its sustainable development goals and of issuing formal host country approval where this is the case. At present, the focus of the National CDM Office is on the approval process for potential CDM projects. However, it also provides support to project developers and plays a part in promoting Mauritius as an attractive location for potential CDM investors.

Some examples of CDM projects under consideration are diverse: e.g. bagasse-based energy projects, wind farms at Britannia, Curepipe Point and Plaine des Roches, and the gas-to-energy project at the Mare Chicose Landfill. Most of these projects are focused on renewable energy generation, due to their immediate mitigation potential.

Following the recommendation of the World Summit on Sustainable Development, 2002, Mauritius, with the financial support of the United Nations Environment Programme (UNEP) developed a National Programme on Sustainable Consumption and Production. In 2007, the National Programme on Sustainable Consumption and Production (SCP)

and SWITCH Africa Green Initiative, which comprises some 42 SCP projects, was approved by Cabinet. The main objective of the National Programme was to 'Achieve more with less' by:

- Decoupling economic growth from use of natural resources;
- Changing energy consumption patterns, technological shifts and behavioural change;
- Increasing resource efficiency, change consumption patterns;
- Increasing in demand and supply of sustainable products and services in the market;
- Promoting/adopting more sustainable lifestyles, consumption choices.

The National Programme on SCP was developed through a systematic stakeholder's consultation process comprising of representatives from different Ministries, the business sector, civil society, academia as well as the media. The following strategic focus areas were identified for the SCP programme framework:

- Resource efficiency in energy, water and sustainable buildings and constructions;
- Education and communication for sustainable lifestyles;
- Waste management;
- Sustainable public procurement, and
- Market opportunities for sustainable products.

In addition to in-country projects, Mauritius is also currently actively engaged in regional climate change initiatives. Mauritius is participating in the **Africa Adaptation Programme**, which aims at establishing an enabling environment to design, finance, implement and monitor long-term and cost-effective adaptation policies and plans. The African Adaptation Programme supports countries to streamline climate change adaptation considerations into core development policies, strategies and plans. The programme considers key biodiversity relevant sectors such as agriculture, environment, fisheries, tourism, water, education and finance.

Mauritius is also part of various regional projects on climate change adaptation and mitigation including the "Adaptation au Changement Climatique dans les Etats de la Commission de l'Océan Indien" project which aims at establishing effective regional cooperation between Indian Ocean Commission (IOC) member states in adapting to the impacts of climate change; The "l'Adaptation de la Petite Agriculture au Changement Climatique dans les Iles de L'Océan Indien pour la diffusion de l'Agro-Ecologie" project, aimed at supporting small farmers and improving their quality of life

through the adoption of sustainable agricultural practices and the regional "Strategy for Addressing Climate Change Impacts in Coastal and Marine Areas of the Western Indian Ocean Region". These projects are critical as a source of lessons for EbA strategies.

4. THE CURRENT, PLANNED AND POTENTIAL CARBON SEQUESTRATION OF THE PROTECTED AREA NETWORK (PAN) OF MAURITIUS

4.1 The Protected Area Network of Mauritius

Like most tropical oceanic islands, Mauritius has high levels of floral and faunal endemism and has suffered high extinction rates caused by a growing human population, habitat destruction and degradation. To safeguard the remaining biodiversity, the Government of Mauritius has established a terrestrial Protected Area Network (PAN) on the mainland, and associated offshore islets, comprising 20 formal state protected areas and covering a total area of 8,027ha. This is supplemented by several different types of less secure conservation areas (covering a total of 7,168ha), under varying levels of protection. By combining biodiversity conservation and carbon stock enhancement strategies, the PAN could play a key role in achieving Aichi Target 15.

However, under current conditions this network is not effectively safeguarding the country's unique terrestrial biodiversity because:

- Some natural ecosystem processes, habitats and species are not adequately represented within it;
- The capacity of the institutions responsible for the planning and management of the protected areas is generally weak; and
- The technical knowledge to contain the threats to biodiversity cost-effectively within the network is under-developed.

The PAN Project is currently attempting to address these issues, especially its expansion through innovative partnerships with various land management agencies, owners and / or lessees. In this context, there is a need to explore how EbA strategies could complement ongoing activities by all concerned stakeholders.

4.2 The carbon stocks of the PAN

In terms of enhancing the carbon sink potential of Mauritius' forests, protected areas (PA) can be divided into two categories: Land Protected Areas (LPA) and Marine Protected Areas (MPA) (Sookun *et al*. 2014). While the methodologies for carbon sequestration assessments for LPA are well developed and agreed internationally (e.g. IPCC 2006), they are still under development for MPA, though a wetland supplement is available (IPCC 2014).

The assessment of carbon sequestered in this study was made according to international guidelines (IPCC 2006, IPCC 2014) and local reporting on GHG inventories (Mauritius Meteorological Services 2010). Current (as of 2015) annual carbon sequestrations for existing and planned officially protected areas (as listed by MAIFS 2015) - National Parks, Nature Reserves and Ramsar Sites - are shown in Table 4.1. together with estimated annual CO_2 sequestration. There areas cover approximately 4% of the total area of Mauritius (including its associated islets).

Table 4.1: Carbon sequestration for the current and Protected Area Network (PA list and surface areas from MAIFS, 2015)

Protected area	Conservation Status	Area (ha)	Annual carbon dioxide sequestered (tonnes) for current PAN
Black River Gorges National Park	National Park	45,360.60	45,360.6
Bras d'Eau National Park		3,430.68	3,430.7
Islets National Park		927.22	1,189.6
Vallee d'Osterlog Endemic Garden	National PA	1,897.50	1,897.5
Perrier	Nature Reserve	9.94	9.9
Les Mares		35.19	35.2
Gouly Pere		75.56	75.6
Cabinet		122.34	122.3
Bois Sec		40.78	40.8
Le Pouce		474.72	474.7
Corps de Garde		623.28	623.3
Islet Nature Reserves (7 islets)		4,130.34	4,130.3
Rivulet Terre Rouge Estuary Bird Sanctuary	Ramsar Site: Wetlands of International Importance	179.40	179.4
Pointe D'Esny		138.00	138.0
Total		**8,325.44**	**57,445.54**

Under the PANES (MAIFS 2017a) it is estimated that the PAN can be expanded to approximately 16% of the area of Mauritius by adding the areas listed in Table 4.2.

Type of site	Authority	Legislation	Area (ha)	Projected annual carbon dioxide sequestered (tonnes)
Mountain Reserves	MAIFS through FS	Forests and Reserves Act, 1983	3,800.00	26,220.0
River Reserves	MAIFS through FS	Forests and Reserves Act, 1983	2740	18,906.0
World Heritage Site: Le Morne	MAC through NHF and LMTF	National Heritage Fund Act, 2003; Le Morne Heritage Trust Fund Act, 2004	783.1	5,403.4
National Heritage Site	MAC through NHF	National Heritage Fund Act, 2003	2.19	15.1
State Forest Lands	MAIFS through FS	Forests and Reserves Act, 1983	Approx. 2,200	15,180.0
Leased State Forest Lands	MAIFS through FS	Shooting and Fishing Leases Act, 1966	Approx. 11,000.00	75,900.0
Undeveloped Pas Géométriques	MHL with FS	Pas Géométriques Act, 1895	803.5	5,544.2
Private Conservation Areas	MAIFS through NPCS	Native Terrestrial Biodiversity and National Parks Act, 2015	2013.0	1,469.7
Craters	Local Municipal Council	Town and Country Act, 1954	Unknown	
Total			**21,541.8**	**148,638.4**

Table 4.2: Carbon sequestration of additional potential PA (surface areas from the PANES)

Adding an area to the PAN does not necessarily result in increased carbon sequestration for reasons outlined in section 1.2. However, it will help to secure the land from developments that could threaten its current carbon sequestration potential.

MPA can also play an important role in carbon sequestration. However, they have not been extensively studied. In this study, an attempt has been made to quantify CO_2 sequestration by above ground biomass found in coastal wetlands (Table 4.3). This excludes partly the carbon pools which are not easily assessed, such as the sediments and underwater ecosystems. Therefore, the MPA, such as the Blue Bay MP, was not included. The MPA containing above-ground vegetation, such as the islets, have thus been assessed. The total CO_2 sequestered amounts to 4,089 tonnes per year.

Table 4.3: Current carbon dioxide sequestration by aboveground biomass in Mauritian MPA (based on data from Statistics Mauritius 2011 and 2016).

Marine & Coastal Protected Areas	**Area (ha)**	**Current annual carbon dioxide sequestered (tonnes)**
Marine - Mauritius		
Blue Bay Marine Park	35	0
Balaclava Marine Park	485	182.37
Poste La Fayette Fishing Reserve	280	105.29
Poudre d'Or Fishing Reserve	2,542	1,911.7
Trou d'Eau Douce Fishing reserve	574	2,15.84
Port Louis Fishing reserve	331	0
Grand Port Zone A	1,716	1,290.5
Grand Port Zone B	112	84.23
Black River Fishing Reserve	797	299.69
		4089.7
Total	**6,541**	**4089.7**

Source: Albion Fisheries Research Centre; Forestry Service and Commission for Environment, Tourism, Fisheries and Marine Parks, Rodrigues Regional Assembly

Challenges

While these estimations highlight the carbon sink role of the current and planned PAN in Mauritius, one has to highlight a few challenges:

- There are no precise carbon stock assessments for different types of forests, and no carbon stock monitoring has taken place on the ground to date;
- There is very limited understanding of the different carbon sequestration rates of different species in Mauritius, though one could suppose that many long-lived indigenous species may hold bigger carbon stocks, for longer periods of time, than quick growing, yet relatively short-lived species such as pine trees;
- Restoring the ecological integrity of indigenous forests and associated ecosystems will require:
- Removing alien plants, thus potentially releasing carbon into the atmosphere, which, in the short to medium term, may not increase the carbon stocks of such forests;
- Indigenous tree species grow much slower than exotic species (e.g. pines), and are thus expected to sequester carbon at a lower rate than the latter.

5. ECOSYSTEM-BASED ADAPTATION OPPORTUNITIES AND CHALLENGES FOR ENHANCING THE RESILIENCE OF THE MAURITIUS PAN

In this section, we focus on EbA strategies for the land PAN exclusively, as per the ToRs. Complementary EbA opportunities and challenges for agricultural and / or other land uses are also briefly discussed but are beyond the scope of work for this study.

5.1 Restoring ecological integrity as the core EbA strategy for the PAN

As EbA measures for the PAN must be compatible with CBD strategic objectives, only adaptation measures that conserve, restore and / or sustainably manage biodiversity values would be acceptable. More specifically, Aichi Target 15 states that "by 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification." However, the formal state PAN currently amounts to only approximately 4%[3] of the surface area of Mauritius.

Besides, most of the PAN is degraded by past land uses and IAS. While it is estimated that less than 2% of the remaining native vegetation cover is in relatively good condition (CEPF 2014), there is broad consensus that the PAN in its present form is not representative of all habitat types in Mauritius and does not adequately protect all species and / or the critical ecosystems required to maintain the ecological integrity of Mauritius' ecosystems. Indeed, native species and habitat outside of the PAN remain under threat from both IAS and development pressures. Institutional overlap in the management of the various types of Protected Areas, as well as limited funding and skills, also hamper effective protected area management (MAIFS 2017a).

As per the PANES (2017), three key work areas need to be pursued and / or strengthened:

- Ecological resilience of the PAN: i.e. EbA measures must target and achieve ecological integrity of habitats, including connectedness, representativeness and integration into the broader landscapes; and
- Financial resilience of the PAN: i.e. EbA measures must be fully funded (i.e. strong commitments required at the highest level), with PAN management agencies actively income source diversification and retention.

[3] Formal State Protected Areas as detailed in the Government of Mauritius (GoM)/United Nations Development Programme (UNDP)/Global Environmental Fund (GEF) Project Document. 2010, p. 32.

- Human capital resilience of the PAN: i.e. institutional and technical capacity must be developed and sustained to implement the measures.

Yet to reach Aichi Target 15, the Republic of Mauritius would need to:

- Significantly expand the formal PAN (Aichi Target 11), and
- Restore its ecological integrity though active restoration work (i.e. not mere invasive species control) (Aichi Targets 11, 12, 14 and 15).

Restoring ecological integrity would constitute the core building block of an EbA strategy for the PAN. It would involve restoration strategies and activities that bring degraded ecosystems to a scientifically defined target: i.e. reaching an ecological integrity threshold. This can be applied to any ecosystem type from mountain and dry forests, freshwater systems to coral reefs.

> However, 'ecological integrity' is a relatively new concept that is being actively discussed by ecologists and a consensus has not yet emerged as to its definition. In 1999, the British Columbia Parks Legacy Panel determined that an ecosystem has ecological integrity when 'the structure, composition and function of the ecosystem are unimpaired by stresses from human activity; natural ecological processes are intact and self-sustaining, the ecosystem evolves naturally and its capacity for self-renewal is maintained; and the ecosystem's biodiversity is ensured.' In Mauritius, those stakeholders consulted defined ecological integrity as being practically synonymous with the degree of native vegetation cover. This is an important component of an ecological integrity index but it is not sufficient alone. A new ambitious definition of ecological integrity (including potentially species diversity and key ecosystem processes) in the Mauritian context should be discussed and agreed by all stakeholders. This could be based upon the METT (Management Effectiveness Tracking Tool), originally designed to measure progress in management effectiveness at particular sites over time (Stolton and Dudley, 2016) and which has been applied for this purpose to many of Mauritius' PA sites.

To restore the ecological integrity of the current and planned PAN, Mauritius should seek inspirations from leading island biodiversity restoration projects (e.g. adopting ambitious biodiversity restoration and re-wilding targets for the whole PAN), namely through the full ecological restoration of islets (e.g. efforts at Ile aux Aigrettes and Round Island) and in Mauritian mainland sites such as Brise Fer and Bel Ombre and Ebony Forest Chamarel, in Grande Montagne and the François Leguat Giant Tortoise and Cave Reserve in Rodrigues, in the Galapagos Archipelago[4], Channel Islands[5], and various islands in the Seychelles – Russel *et al*., 2016) and through the developments of ecologically representative "mainland islands" throughout its PAN which would

[4] URL: http://www.galapagos.org/conservation/conservation/project-areas/ecosystem-restoration//.
[5] URL: https://www.nps.gov/chis/learn/nature/island-restoration.htm

fully exclude exotic predators (e.g. Zealandia Sanctuary in New Zealand[6]). This is one of the most promising ways for Mauritius to be able to compete with other island eco-tourism destinations in a world where tourists are becoming more knowledgeable, have easy access to information and want value for money.

Restoration of PAN ecosystems could take place in several ways, including through a combination of activities such as avoided deforestation (Aichi Target 5), the prevention forest degradation (Aichi Target 5), reforestation via native species, indigenous species reintroduction (e.g. birds, reptiles), exotic species (mammals, birds, reptiles, plants, insects) control and / or eradication (Aichi Target 9), and the restoration of ecosystem functions and processes (e.g. wetland and river functionality). The former two approaches could target both the existing PAN (only a few hundred hectares have seen their ecological integrity improved through IAS control to date) and the broader potential PAN (i.e. there are an estimated 25,000 ha of forested land privately owned or leased to private landowners, managed mostly for deer hunting with clearings for pasture). In addition, the latter approaches could involve establishing new indigenous ecosystems in sensitive areas, including promotion of farm and homestead forestry and agroforestry practices in agricultural lands within (e.g. targeting river reserves) or adjacent to an extended PAN. Ecosystem restoration must be based on indigenous tree species to comply with CBD obligations (Aichi Target 15).

Currently, however, Mauritius plantation forests are dominated by exotic species (particularly Eucalyptus and Pine species). Recent discussions with various stakeholders highlighted proposals to replace exotic species with native species in all afforestation / reforestation activities undertaken by the Forestry Service. While this suggestion is important to restore biodiversity, the consensus is that replacement of pines with indigenous species should be done progressively, in a controlled manner, to avoid destabilising the ecosystems where exotic trees are already well established (e.g. to avoid soil erosion). Also, such replacement should be done in full consideration of the values of pine forests (e.g. timber value, recreational features for landscape beautification and tourism). Recognising potential trade-offs and discussing options with stakeholders is key to community acceptance. This calls for the development of practical guidelines for ecosystem restoration while minimising carbon losses. Forest restoration should mainly be targeted at deforestation and IAS hotspots, where there is high risk of loss of biodiversity, while reforestation should mainly focus on low value areas both within and outside the PAN.

[6] Zealanda is a fully-fenced urban private reserve, with an extraordinary 500-year vision to restore a Wellington valley's forest and freshwater ecosystems as closely as possible to their pre-human state. The 225 hectare 'ecosanctuary' is a ground-breaking conservation project that has reintroduced 18 species of native wildlife back into the area, 6 of which were previously absent from mainland New Zealand for over 100 years. URL: https://www.visitzealandia.com/.

There exist untapped opportunities to assess and enhance the carbon sequestration potential of marine ecosystems which could not be investigated in this study because of methodological challenges. This presents a strong argument to initiate studies in this area and to potentially use the findings as a tool to raise funds for projects to restore the ecological integrity of coastal and marine ecosystems.

5.2 Additional EbA opportunities in coastal, freshwater and marine ecosystems

Within the context of an expanded MPA network, ecological restoration of marine and coastal ecosystems would be critical to resilience of coastal ecosystems. Ecological restoration of mangrove ecosystems should be a priority, through rehabilitating existing mangrove forests and establishing new mangrove habitats. For instance, ecological restoration of mangroves has proved to be a key to coastal resilience option in India, Indonesia, Malaysia, Sri Lanka and Thailand, countries that suffered in the 2004 tsunami. Through the Green Coast project, supported through the WWF and the International Union for Conservation of Nature (IUCN), local communities in these countries were engaged in planting more than 3 million seedlings and re-establishing over 1,100 hectares of coastal forest and mangroves, helping to protect against storm surges and sea level rise. These activities enhanced resilience of the coastal and marine ecosystem which then enabled about 91,000 people to be protected from coastal degradation and extreme events, while enhancing their livelihoods[7].

Ecological restoration of coral reefs can take direct forms. Direct approaches may include attaching coral nubbins directly to the substrate, using either with nails and cable ties for attachment to limestone pavements, or cable ties for attachment to recently deceased coral colonies. Nubbins are collected from areas suffering severe fragmentation, for instance because of fisheries-related damages to reefs. Some of the ongoing coral reef restoration activities by the Mauritius Oceanography Institute, under the Ministry of Ocean Economy, Marine Resources, Fisheries and Shipping, should be up scaled and enhanced.

Ecological restoration of wetlands should focus on the restoration of natural ecosystem processes, for instance when river systems and wetlands have been drained and constrained by physical infrastructure. Ecological engineering solutions to rehabilitate coastal defences to protect land from rising sea levels can also be an important option for building resilience of coastal zones including wetlands and mangroves. These may involve deliberately breaching the sea walls to allow the coastline to recede to a new line of defence further inland. This creates space for intertidal habitat, such as mudflats and saltmarsh, to develop. Such ecological engineered solutions could stabilise

[7]https://www.wetlands.org/greencoast

saltmarsh upon which vegetation cover can be established to reduce flood risks and reducing wave heights[8].

5.3 Promoting a landscape EbA approach

Landscape EbA strategies are critical for enhancing biodiversity and livelihood resilience to the impacts of climate change. Complementary to protected area networks, landscape EbA approaches enable the migration of species across altitudinal / topographic and / or climatic gradients to support their survival during tougher climatic times. This approach applies to all terrestrial and marine ecosystems, both with the PAN and outside of it.

Landscape EbA strategies bring various ecosystems, land uses, actors and tenure regimes under one overarching management approach. This is critical because most ecosystems are interconnected in their functions, spatial locations as well as temporal evolution. For instance, enhancing and protecting the connections and environmental flows between forests, wetlands and agricultural land uses across catchments is key in restoring the ecosystems, which in turn enhances water filtration and water availability for agriculture. Indeed, protected and well managed wetlands are key in filtering our nutrients and reducing eutrophication in the rivers.

To date, the GoM, through the PAN Project, has provided a good platform to support a landscape EbA strategy. Incorporating private land owners / lessees; and various incentives under the PAN could be very promising. Establishing effective catchment management forums / committees to enhance stakeholder participation in linking both upstream and downstream management activities should also be promoted.

5.4 Cost uncertainties

The investment and operational costs of restoring the ecological integrity of the PAN is highly problematic. It is affected by several factors:

- Focus to date on invasive species control, not actual ecosystem restoration, with an approximate cost of US$3,000 per hectare for initial weeding and US$850 for maintenance weeding at (US$ as at December 16, 2016; 1 USD = 36,01 MUR) (information gathered via meetings with NPCS staff);
- Very limited understanding of the functions and processes of the various threatened ecosystems of Mauritius (only charismatic animal and plant species are known);

[8] Wave heights can be reduced by up to 50% over the first 10-20 m of vegetated saltmarsh surface.

- No clear target for ecological integrity restoration for PA, apart from a few hundred hectares of managed conservation areas of the Black River Gorges National Park.

Some of the best-known examples of effective ecological integrity restoration in Mauritius is the work being spearheaded on Ile aux Aigrettes (MWF)[9], Round Island (MWF / NPCS) and Francois Leguat Tortoise and Cave Reserve managed by a private sector initiative. There is also work being undertaken on the Mauritian mainland such as that spearheaded by NPCS in the Black River Gorges National Park (notably at Brise Fer and Bel Ombre), the Forestry Service (for example, at Mon Vert) and the private sector (for example, at Ebony Forest Chamarel). Yet, no comprehensive information is available to date about the total and detailed costs (and associated activities) of these initiatives over the past decades. It would be critical to support the MWF and others in assessing their net contribution to society through their restoration activities. Using Ile aux Aigrettes as an example, it has relatively little financial value in its current land use (i.e. minimal location fee paid by MWF to the Republic of Mauritius, though some ecotourism activities), it has irreplaceable biodiversity values due to the work done by MWF and its partners. In other words, what is the ecological return (habitats, species, ecosystem functions and processes) on investment (equipment, labour, transport, etc.) for this critical natural capital asset for Mauritius? Answering this question, with regard to Ile aux Aigrettes and other restoration sites, would likely go some way towards a better understanding the spatial diversity of ecological integrity restoration costs in the various PAN ecosystems.

The fact remains that, given that there are thousands of hectares to restore, the costs are likely to be highly significant (in the range of dozens of millions of USD for the entire PAN).

5.5 Funding opportunities and uncertainties

A structured approach to fundraising will be needed to achieve Aichi Target 15. Certain measures have been implemented or are already in the pipeline. MWF, for example, is charging for guided tours of Ile aux Aigrettes and Francois Leguat Giant Tortoise and Cave Reserve charges for admission and guided tours. There are plans to charge an entrance fee for the Black River Gorges National Park. Building upon these beginnings, two key tools are outlined below:

- New eco-tourism activities could provide some financial support to the restoration of ecological integrity of key PA (e.g. though new public – private partnerships for new tourism routes and products such as low impact, low volume accommodations in key sites). While ecotourism development presents both a potential to cater for the new demand as well as an avenue for

[9] The NGO has been investing significant resources in the restoration of one of the most threatened Mauritian habitats: i.e. the coastal ebony forest and its associated biodiversity (birds, reptiles).

tourism product diversification, such developments must avoid negatively impacting on biodiversity values. To this end, successful ecotourism projects must:

- Be well planned, financed, managed and marketed to meet the stringent environmental and recreational demands of a true ecotourism development;
- Effectively promote the preservation of entire local ecosystems, not just individual species, vistas or sites; and
- Be economically viable to attract private sector financing.

- Incentive systems, such as Payment for Ecosystem Services (PES), has gained legitimacy as a tool for actively engaging multiple actors including non-State ones, such as the private sector, in natural resource conservation and could be a useful tool for building a PAN that is resilient to the impacts of climate change. PES is defined as 'a voluntary transaction where a well-defined ecosystem service is bought by a buyer from an ecosystem service provider if and only if the ecosystem service is secured' (Wunder 2005). For instance, a PES scheme in Mauritius could provide economic incentives for landowners to protect or restore biodiversity, control IAS and / or store carbon. Because the Mauritius GHG emission budget indicate that forests offer a net sink to Mauritius emissions, schemes should be developed to support the ecological restoration of forests. There are two main complementary sources of funding for this:
  - The global climate change negotiations have led to the enactment of a programme on reducing emissions from deforestation and forest degradation and sustainable forest management (REDD+). The basic principle behind REDDD+ is that developing countries who can conserve their forests can be financially compensated for doing so based on carbon sequestered and biodiversity conserved. Among potential sources of funding are the Green Climate Fund (GCF), the Adaptation Fund (AF), the World Bank's Forest Carbon Partnership Facility, UN-REDD+ as well as the Global Environment Facility. Bilateral climate funds could also be targeted. However, competition for funds is extremely high (very low values per carbon credit are currently experienced, making carbon project development unattractive) and many carbon-related pre-requisites (e.g. solid carbon stock baseline assessment, in-situ carbon stock monitoring systems, precise carbon models of native species, among others) would most likely have to be addressed to attract donors and strategically position the Republic of Mauritius against typical REDD+ countries (i.e. those which hold significant natural forests such as Brazil and Indonesia).
  - Local, Mauritian sources of funding could also be explored. These could diverse, ranging from bilateral agreements between ecosystem services providers and beneficiaries (e.g. catchment services, such as water supply, financed by private companies relying on significant amounts of clean water), dedicated taxes (existing and / or new) channelled into

a (non-sinking, perpetual with only interests spent) endowment fund (e.g. tax used to finance the acquisition of coastal natural assets by the Conservatoire du Littoral in France; http://www.conservatoire-du-littoral.fr/) with amounts allocated based on the ecological return of investments (e.g. through competitive calls of PA management agencies) and a new dedicated non-sinking offset fund, based on biodiversity net gain principles, which would be financed by all new projects with residual impacts on biodiversity throughout the Republic of Mauritius. However, such schemes would require strong political support, at the highest level, as well as significant efforts in stakeholder consultations to ensure their buy-in their design and implementation phases. A promising avenue which should be explored in Mauritius is increased water charges, with part of that revenue being invested back into management of the pine trees and invasive plants in the two catchments. The impact of pine trees and other introduced plants on ecosystem services including water availability, conservation and recreation is investigated in the NBSAP preparatory study Valuation of ecosystem services provided by the Mare Longue and Mare aux Vacoas catchments (MAIFS 2017c)

5.6 Enabling conditions for implementing EbA strategies

This section outlines some key enabling conditions that could support the implementation of the above strategies.

Cross-sectoral coordination and policy analysis

Cross-sectoral coordination is critical for implementing the proposed EbA options. These often transcend different sectors and can be coherently and effectively implemented by engaging multiple sectors. Climate change is insufficiently mainstreamed in the current activities of various sectors thus they are not effectively supportive to short and long term decision-making. There should be new approaches to analyse existing policies from multi-sectoral and multi-stakeholder perspectives, building on existing frameworks and leverage on skills across sectors and stakeholders.

Build research, technology transfer and innovation systems

Climate change remains a multi-scale and multi-regional. This means most solutions and resources for tackling climate change cut across national boundaries (e.g. south-south or north-south technology transfer, capacity building and resource mobilisation as identified by the IPCC 2013 and the Paris Agreement). Building research and innovation systems will be critical in generating new insights (e.g. in-situ carbon stocks and sequestration rates of different habitats and species, comparing exotics and indigenous species) and evidence on domesticating adaptation technologies. Technologies that are promoted by the international community through the UNFCCC (e.g. REDD+, GCF, CDM) require well-functioning innovation systems to ensure that new technologies are

sustainably implemented within the country's socioeconomic and policy context. For a successful achievement of the above adaptation strategies, there should be strong technological innovations involving research support and investments, institutional innovations, and policy innovations. Building such systems should be incremental over time, not a one-off event.

The post-Kyoto climate regime has paid increased attention to the role of innovation, technology and research systems in negotiating and implementing climate change decisions in Africa. The 21st Conference of Parties to the UNFCCC 'the Paris Agreement' acknowledges that technology transfer and innovation systems are key to addressing climate change and especially for Africa. The Technology Executive Committee (TEC) to the UNFCCC recently launched a work stream on "strengthening innovation systems (IS) for climate technology transfer (TT) and development" (see page 3 of the TEC rolling work plan TEC/2015/10/12). This is the first time building innovation systems has been considered under the Convention. It represents a significant opportunity for African countries to leverage support via the UNFCCC and other development agencies to strengthen their capabilities around climate technologies in ways that will underpin effective design, lobby for and implement technological decisions that resonate with Africa's circumstances, long term economic growth and overall resilience of African people.

Context specific and targeted climate change information and communication

Climate change impacts on different ecosystems in different ways. As such, climate information generated from various government departments, including the Meteorology and the Climate Change Division, ought to be packaged in line with the needs of various ecosystems. Currently, the study found out that climate change information and dissemination remains general and sometime vague making it difficult to be used or to inform sectoral decisions on particularly ecosystems. Agencies concerned with climate information must use initiative mechanisms for repackaging the evidence on climate change into forms acceptable to various stakeholders responsible for ecosystem management in Mauritius. Repackaging the information into different non-technical forms including blogs, brochures, and press releases, which can be easily understood by farmers, the private sector, extension workers, grassroots NGOs and policy makers is a critical strategy for achieving restoration of ecological integrity of the PAN.

Capacity building

Capacity building and PA creation is critical for supporting EbA. This study found that most stakeholders, including community members, do not have much information and are not aware of the nature of ecosystem services, their value and how best they can manage them. As such, capacity building on EbA strategies should target protected area management staff (NPCS, FS) and adjacent landowners (e.g. hunting operators which could be included in the expanded PAN), as well as

relevant government agencies to provide the adequate support to on-the-ground actors. It is very important to increase the capacity to assess carbon pools in marine ecosystems.

Partnerships

Building partnerships with various regional and international organisations, NGOs, Civil Society among others, is critical for implementing EbA options. Such partnerships will enable the country to access necessary expertise and resources to reach Aichi Target 15. This is because three are certain funding sources or capacity building opportunities that specifically target these non-state organisations. These non-state organisations can access such funds and support the government in implementing the adaptation options.

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