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MADAGASCAR
COUNTRY ENVIRONMENTAL ANALYSIS

PROMOTING GREEN, RESILIENT, AND INCLUSIVE DEVELOPMENT

Public Disclosure Authorized

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ACKNOWLEDGEMENTS

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The report was reviewed by Nigel Ross Hughes (Senior Natural Resources Management Specialist, SAEE2), Andre Aquino (Lead Environmental Specialist, SEADR), Giovanni Ruta (Lead Environmental Economist, SEAE1), and Natsuko Toba (Economist, CERCD). Special thanks to Idah Pswarayi-Riddihough (Country Director, AECS2), Africa Olojoba (Practice Manager, SAEE3), Marie-Chantal Uwanyiligira (Country Manager, AEMMG). Valuable contributions were also made by World Bank colleagues, in alphabetical order, including Mampionona Amboarasoa (Agriculture Economist, SAEA2), Raymond Bourdeaux (Manger, Operations AECS2), Stephen D'Alessandro (Sr. Agriculture Specialist, SAEA2), Prisca Mamitiana (Private Sector Development Specialist, EAEF2), Michel Matera (Sr. Disaster Risk Management Specialist, SAEU2), Alisha Pinto (Clean Energy Consultant, IEEES), Cristian Quijada Torres (Sr. Private Sector Specialist, EAEF2), Jingyi Wu (Energy Consultant, IEEES), Yabei Zhang (Sr. Energy Specialist, IEEES). Diana Styvanley (External Affairs Officer, ECRAE) provided communications support for the CEA, and Andrianina Rafamatanantsoa (Sr. Program Assistant, SAEE3) and Diane Ratiarisoa (Team Assistant, AEMMG) provided invaluable administrative support for the team. Contributions to the CEA were supported in part by funds from PROBLUE, PROGREEN and the Climate Support Facility. The report was edited by Claire Elizabeth Baumann and Zoe Ann and was designed by Roots Advertising.

ACRONYM

ADES	Association pour le Développement de l'Energie Solaire Suisse
AFARB	Action en Faveur de l'Arbre
AFD	Agence Française de Développement (French Development Agency)
AfDB	African Development Bank
ANGAP	Association National pour la Gestion des Aires Protégées (National Protected Areas Management Association)
BE	Blue Economy
CASEF	Projet de Croissance Agricole et de Sécurisation Foncière (Madagascar Agriculture Rural Growth and Land Management Project)
CEA	Country Environmental Analysis
CLP	Comité Local du Parc (Local Park Committee)
CMCS	Centre Malgache de la Canne et du Sucre (Malagasy Sugarcane Center)
CNEB	Comité National de l'Economie Bleue (National Committee of the Blue Economy)
COAP	Code sur les Aires Protégées (Protected Areas Code)
COBA	Communauté de Base (Community Based Organizations)
COMATSA	Corridor Marojejy-Anjanaharibe-Sud-Tsaratanana (Marojejy-Tsaratanana-Anjanaharibe Corridor)
COSAP	Comité d'Orientation et de Soutien à l'Aire Protégée (Protected Area Orientation and Support Committee)
COVID-19	Coronavirus-19
CTDs	Collectivités Territoriales Décentralisées (Decentralized Territorial Units)
CT-PNEC	Cellule Technique du Programme National d'Ethanol Combustible (Secretariat of the Fuel Ethanol Program Technical Unit)
DWT	Deadweight tonnage
EEZ	Exclusive Economic Zone
EGEDEN	Etablissement de Gestion des Déchets de Nosy-Be (Nosy-Be Waste Managemenet Facility)
ERS	Electronic Reporting Systems
ESIA	Environmental and social impact assessment
ESMAP	Energy Sector Management Assistance Program
FAPBM	Fondation pour les Aires Protégées et la Biodiversité de Madagascar (Madagascar Biodiversity Trust Fund)
FEE	Foundation for Environmental Education
FILDD	Fond d'Investissement pour le Développement Durable (local investment fund for sustainable development)
FVP	Floating Photovoltaic Power
GCET	Global Code of Ethics for Tourism
GCF	Gestion Contractualisée des Forêts (Contractualized Forest Management)
GDP	Gross domestic product
GELOSE	Gestion Locale Sécurisée (Secure Local Management)

GHG	Greenhouse Gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (German Society for International Coorperation)
GRID	Green, Resilient, and Inclusive Development
GSTC	Global Sustainable Tourism Council
GWH	Gigawatt hours
HAP	Household Air Pollution
ICBG	International Cooperative Biodiversity Groups
ICS	Improved Cookstoves
IDDRI	Institut du Développement Durable et des Relations Internationales (Institute for Sustainable Development and International Relations)
ILM	Integrated Land Management
ISO	International Organization for Standardization
IUU	illegal, unreported and unregulated
LMMA	Locally Managed Marine Areas
LOFM	Laboratoire d'observation de la Foret à Madagascar (Forest Observation Laboratory in Madagascar)
LPG	Liquefied petroleum gas
MAL	Ministère de l'Agriculture et de l'Elevage (Ministry of Agriculture and Livestock)
MATSF	Ministre de l'Aménagement du Territoire et des Services Fonciers (Ministry of Land Planning)
MECIE	Mise en compatibilité des investissements avec l'environnement (Making investments compatible with the environment)
MEDD	Ministère de l'Environnement et de Développement Durable (Ministry of Environment and Sustainable Development)
MICC	Ministère de l'Industrialisation, du Commerce et de la Consommation (Ministry of Industrialization, Trade and Consumer Affairs)
MID	Ministère de l'Intérieur et de la Décentralisation (Ministry of Interior and Decentralization)
MNP	Madagascar National Parks
MSP	Marine Spatial Plans
MTF	Multi-Tier Framework
MTPLM	Ministry of Territorial Planning and Land Management
MWSH	Ministry of Water, Sanitation and Hygiene
NDC	Nationally Determined Contribution
NEAP	National Environmental Action Plan
NFD	National Forest Domain
NGO	Non-Governmental Organization
NMC	Northern Mozambique Channel

NORAD	Norwegian Agency for Development Cooperation
NPP	Net primary productivity
NVDI	Normalized Difference Vegetation Index
OLEP	Organe de Lutte contre les Évènements de Pollution (Organ for the Control of Pollution Events)
ONE	Office National pour l'Environnement (National Office of the Environment)
ONTM	Office National du Tourisme de Madagascar (National Tourism Office)
OTEC	Ocean Thermal Energy Conversion
PADAP	Projet d'Appui à une Agriculture Durable par une Approche Paysage (Sustainable Landscape Management Project)
PAGS	Plan d'Aménagement et de Gestion Simplifié (Simplified Planning and Management Schemes)
PEM	Plan Emergence de Madagascar
PES	Payments for Ecosystem Services
PIC1	first Integrated Growth Poles project
PM	Particulate Matters
PPNT	Propriétés Foncières Privées non Titrées (Untitled private property)
PRCPB	Projet de Résilience Climatique pour la Préservation de la Biodiversité (Climate Resilience for Biodiversity Preservation Project)
REDD+	Reducing Emissions from Deforestation and Forest Degradation
RFR	Réserves Foncières pour le Reboisement (Land Forest Reserve Strategy)
SAC	Schéma d'Aménagement Communal (Municipal Development Plan)
SAIC	Schéma d'Aménagement InterCommunal (Intermunicipal Development Plan)
SCD	Systemic Country Diagnostic
SESA	Strategic Environment and Social Impact Assessment
SLMP	Sustainable Land Management Plans
SMA	Autonomous Maintenance Service of the City of Antananarivo
SOP	Series of Projects
SWIOFish2	Second South West Indian Ocean Fisheries Governance and Shared Growth Project
SWM	Solid waste management
UNFCCC	United Nations Framework Convention on Climate Change
VOI	Vondron'Olona Ifotony (grassroot community)
WDPA	World Database on Protected Areas
WTTC	World Travel and Tourism Council
WWF	World Wide Fund for Nature
ZODAFARB	Zone Délimitées pour l'Action en Faveur de l'Arbre (Area of Action for the Protection of Trees)


Photo credit : Mamy Razafindrakoto

EXECUTIVE SUMMARY

Madagascar remains one of the poorest countries in the world. The country has endured stubbornly high poverty rates and limited economic growth for decades. Madagascar sustained modest Gross Domestic Product (GDP) growth between 2013 and 2019, but by 2020, with the onset of the COVID-19 pandemic, the country's export revenue and private investment plummeted, triggering a GDP contraction of 7.2 percent. That economic deterioration resulted in an all-time high poverty rate of 80.7 percent in 2021.

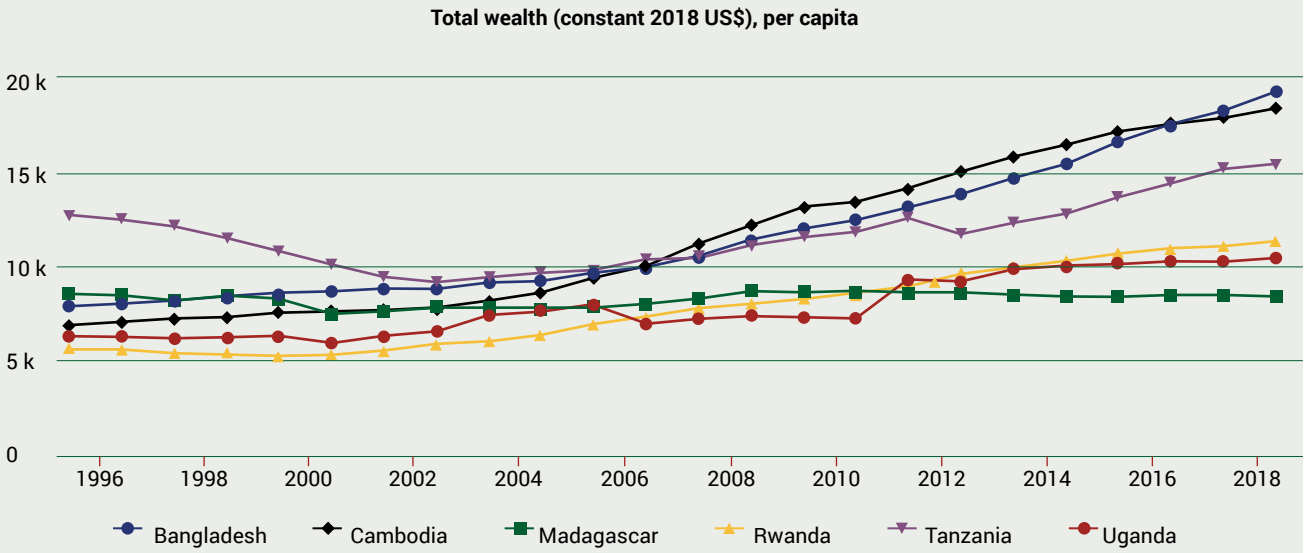
While the island nation struggles with economic poverty, Madagascar is rich in natural resources. With dense forests surrounded by almost 5,000 km of coastline, multiple economic sectors have the potential to grow and contribute to poverty reduction. Tapping into and investing in the development of Madagascar's natural resources offers the country a path toward sustainable economic development. To do so will require careful management to ensure these resources are not degraded or destroyed in the process.

The Country Environmental Analysis (CEA) report assesses three areas that are key to promoting Green, Resilient, and Inclusive Development in Madagascar: sustainable landscape management, the Blue Economy, and nature-based tourism. Additionally, the CEA highlights the persistent and emerging environmental challenges confronting the country, from air pollution to waste management, and the need to manage these to ensure sustainable development.

DEVELOPMENT CHALLENGES, NATURAL ASSETS, AND ENVIRONMENTAL DEGRADATION

Between 1995 and 2018, Madagascar was one of only 22 out of 146 countries where wealth per capita decreased. Total wealth, defined as the sum of natural, produced, and human capital along with net foreign assets, increased by 91 percent between 1995 and 2018 in the country. At the same time, a 94 percent increase in population triggered a two percent decrease in total wealth per capita, the measure of the sustainability of growth. Among its five peer nations – Bangladesh, Cambodia, Rwanda, Tanzania, and Uganda – Madagascar's total wealth per capita dropped from the second highest in 1995 to the lowest in 2018 (Figure ES.1).

Figure ES.1. Total Wealth per Capita Trends in Madagascar and Peer Countries from 1995 to 2018

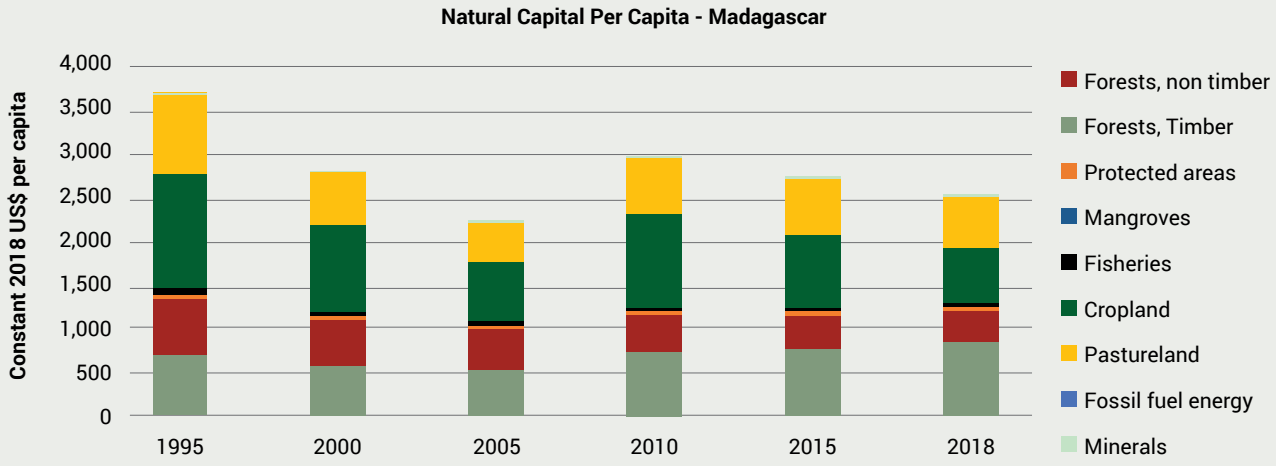


Source: The Changing Wealth of Nations, 2021. Managing Assets for the Future, Washington D.C.: World Bank.

This drop was largely due to a decline in natural capital wealth per capita. Between 1995 and 2018, produced capital per capita remained mostly constant, and human capital per capita increased. Meanwhile, Madagascar's renewable natural capital per capita (the sum of forest lands, agricultural lands, pasture lands, terrestrial protected areas, mangroves, and fisheries) dropped in value by 31 percent (Figure ES.2).

Despite its abundance, Madagascar's natural capital remains undervalued and underdeveloped, limiting its contribution to the country's development. These assets include varied ecosystems, unique biodiversity, forests, fisheries, and agricultural lands. Agriculture, production forestry, and fisheries are dominant economic sectors, accounting for approximately 25 percent of GDP and 75 percent of employment. But these sectors have had minimal growth in productivity, due to limited access to the technology and infrastructure necessary for growth. Without improved management and leveraging of Madagascar's natural wealth, it will be harder for the country to unlock the green, resilient, and inclusive development necessary to alleviate poverty and promote social and economic growth.

Figure ES.2. Change in Natural Capital Wealth per Capita for Madagascar between 1995 and 2018



Source: World Bank. 2021. Changing Wealth of Nations: Managing Assets for the Future.

Madagascar's varied natural assets provide vital services to households and sectors across the country. Healthy landscapes provide key watershed protection functions, sustaining and regulating water flows for irrigation, electricity generation, and water supply, and limiting downstream flooding. The coastline and marine ecosystems offer significant potential for Blue Economy sectors such as fisheries, aquaculture, and shipping. And the country's rich biodiversity, of which an estimated 80% can only be found on the island, represents an opportunity for growing nature-based tourism offerings.

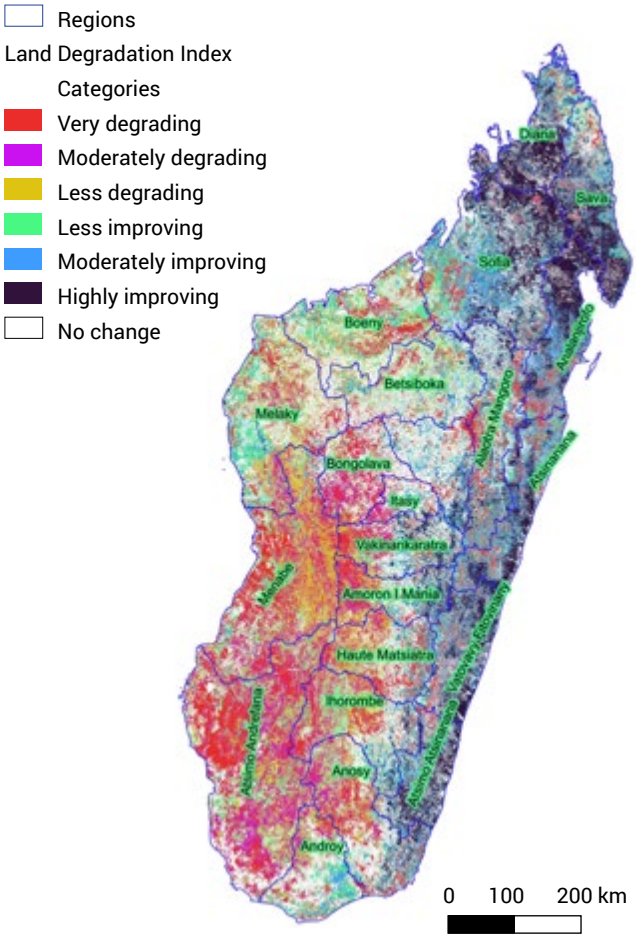
Despite the critical services its environment provides, widespread degradation is imposing significant costs on people and the economy. From deforestation to overfishing, the mismanagement and degradation of Madagascar's natural assets are taking an environmental, social, and economic toll. Additionally, the country faces emerging environmental challenges, such as insufficient solid waste management infrastructure. To advance sustainable, lasting economic growth, these issues must be addressed through careful management.

MAINSTREAMING LANDSCAPE MANAGEMENT TO PROMOTE ECONOMIC DEVELOPMENT

Madagascar's landscapes have been uniquely impacted by land degradation. Degradation has been particularly severe in the western and southwestern regions, but landscapes across the country have been affected. For example, the country's forests have been greatly diminished. Accounting for an estimated 29 percent of land area in 2000, Madagascar's forests now cover only 21 percent due to deforestation for grazing and agricultural lands, which contribute to some of the highest rates of erosion and downstream flooding in the world (Figure ES.3).

Despite Madagascar's natural abundance of water, land degradation has caused declines in water yield since 1990. While a decrease in annual rainfall has been a key contributing factor in the over 65,000 million m^3 decline, changes in land use and declining vegetation cover have also reduced landscapes' ability to capture and store rainfall, increasing runoff and the potential for flooding. Moreover, sediment loads from erosion have greatly reduced the usable storage and capacity of dams across the country to generate electricity or deliver water for irrigated agriculture.

Figure ES.3. Land Degradation Trends in Madagascar 1990 – 2020



Source: World Bank Team Estimation.

Reliance on biomass is another leading driver of deforestation. The high dependence of much of the population on fuelwood for cooking causes degradation, and has severe health and productivity impacts, particularly on women and children. Air pollution– largely indoor– is the third largest risk factor for death and disability in Madagascar, causing nearly 17,000 deaths and 850,000 days lost to illness annually.

The economic cost of land degradation since 2000 is estimated at over US$6.7 billion, amounting to 1.78 percent of GDP per year. This is a conservative estimate, only considering lost yields of main crops due to erosion, lost energy production due to declining water availability for hydropower, potential cost of dredging reservoirs, and the opportunity cost of unrealized carbon credits on the international market.[1] Likewise, losses in crop production due to erosion and land degradation are estimated at US$4.1 billion, with

1 This is a partial estimate as it leaves aside sectors that are also affected by the depletion of natural capital, for example tourism, and some crops due to data limitations.

a yearly average of US$141.4 million, equivalent to five percent of agricultural GDP. The economic impact is mirrored by significant social consequences as well, with threats to food security, biofuel availability, and loss of income.

Integrated landscape management can help reverse land degradation, restore ecosystem services, and contribute to economic development. To leverage land and water resources for economic growth, Madagascar needs to:

- *Mainstream landscape approaches into larger scale investments.* These include investments in water resource development for hydropower and irrigation. Maintenance of upstream watershed ecosystem functions, such as water flow regulation and sediment retention, is key to their sustainability. Mainstreaming needs to be complemented with adapting landscape approaches to specific contexts, including through simplified project design, while exploring the scope for greater use of environmental finance instruments such as REDD+ and payments for ecosystem services to finance these investments.
- *Promote land tenure security and improve the regulatory framework for community-based natural resource management.* Despite efforts to modernize and decentralize land administration, less than 8,000 formal land titles are issued annually, and around 10 million plots are unregistered. The legislation regulating specific statutes on new categories of forest lands and community rights to these lands has yet to be fully detailed. Land access and property rights incentives related to reforestation need to be effectively enforced, and there must be greater consistency between the legislation for community-based natural resource management, the forest law, and the land tenure law to promote effective management.
- *Invest in productive forestry and upscale support for transition to more energy-efficient and cleaner cooking.* To reduce deforestation, Madagascar must facilitate the transition to clean, energy-efficient cooking. These efforts will also improve the health of women and children. Investments must be made in community woodlots, trees on agricultural land, and private sector plantations to increase the supply of sustainably sourced woodfuel and charcoal for construction.

FULLY REALIZING THE POTENTIAL OF THE BLUE ECONOMY

Madagascar has the longest coastline in Africa (5,600 km) and the fourth largest Exclusive Economic Zone in the world (over 1.22 million square kilometers), an area nearly double its landmass. Uniquely positioned with the open Indian Ocean on one side and the protected waters of the Mozambique Channel on the other allows for a rich diversity of marine habitats, ecosystems, and flora and fauna. The vast coastline and biodiverse-marine ecosystems– including over 250,000 hectares of mangroves– support both large-scale and local marine sectors.

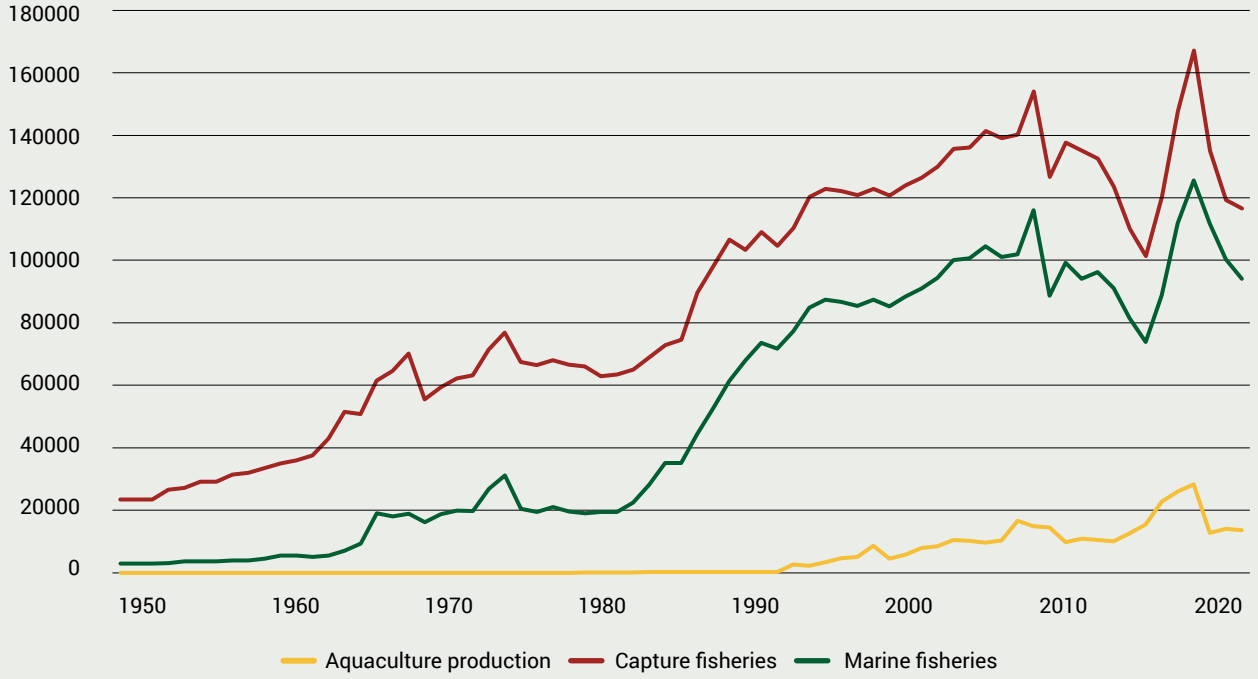
However, these ecosystems and the services they provide are at risk, which in turn threatens the development of the industries that depend on them. Pollution, overexploitation, and anthropogenic pressures have started to degrade these natural resources, effects that are further exacerbated by the impacts of climate change: increased sea-surface temperatures, frequency and intensity of extreme climatic events, and coastal erosion.

Madagascar has yet to fully tap into the potential contributions of its marine natural capital to economic development. The Blue Economy is just starting to develop and is primarily focused on marine-related exports and fisheries. The latter is particularly robust, with an annual production capacity of US$750 million, equivalent to more than seven percent of the national GDP. Unfortunately, the country's marine fishery resources are poised to be fully overexploited in most coastal areas, with evidence of overfishing in all segments of the sector.

Madagascar needs to build on its ongoing efforts to transition to a Blue Economy, leveraging its blue assets for economic development. Since 2015, efforts have been made to create the necessary framework for this transition, including the creation of a Ministry of Fisheries and the Blue Economy in 2021. In addition to these efforts, there is a need to:

- *Finalize, adopt, and implement a Blue Economy strategy.* An effective strategy provides the framework to enhance the sustainability of oceanic sector development through identifying best practices, prioritizing key sectors to integrate, and determining the appropriate locations for the development of future industries. This will require a consultative and collaborative process and will allow for the country's vision for integrated development of the maritime and coastal sectors to be realized while ensuring the ecosystems that support them are preserved.

Figure ES.4. Madagascar Overall Capture Fisheries, Marine Fisheries, and Aquaculture Production (tons) from 1950 to 2020



Source: FAO, 2022.

- *Formulate and implement Marine Spatial Plans (MSP) to guide the development of the Blue Economy and private sector investments.* An overarching framework should be prepared for the development of subnational MSPs at the regional level. MSPs will provide a mechanism to make early policy decisions on the use of the marine space for activities of the blue sectors, avoiding conflicts by looking at the necessary trade-offs ahead of time. They will also provide recommendations for revisions to key marine sector policies for better alignment and implementation of Madagascar's Blue Economy strategy.
- *Improve investment climates for emerging industries and incentivize increases in compliance and mitigation of impacts on marine ecosystems.* The regulatory framework for investment in the sectors of the Blue Economy, including emerging ones, should be reviewed. This will help identify how best to lift barriers and support improved compliance within key sectors, with measures for mitigating impacts on the environment. Capacity should also be built across the legal system to facilitate investments and better enforce compliance within Blue Economy sectors at national and subnational levels.

BIODIVERSITY AND NATURE-BASED TOURISM: AN UNTAPPED ASSET

Madagascar's biodiversity, some of the most robust on the planet, is an asset that offers major contributions to domestic economic growth from tourism. The tourism industry leverages the country's astounding biodiversity, landscapes, and unique culture to provide jobs for communities living near protected areas, both directly (e.g., guides, drivers, and hotel and restaurant staff) or indirectly (e.g., food and services to the hotels and restaurants). Tourism is also a significant contributor to local, regional, and national value chains (e.g., hospitality, travel agencies, handicraft, and agriculture), as well as to park fees, tax revenues, foreign currency, and foreign direct investment.

Tourism is a growing sector in the country, with marine tourism appearing to be increasingly attractive to visitors. When compared to neighboring countries in the region, the potential for tourism growth is significant in Madagascar, largely due to the high interest in coastal tourism. In 2019, Madagascar's tourism sector, the majority of which is nature-based, contributed 12.7 percent[2] of GDP and 9.9 percent of

2 WTTC: Madagascar. Research Highlights 2021. Available at: https://wttc.org/Research/Economic-Impact/moduleId/704/itemId/153/controller/DownloadRequest/action/QuickDownload. Updated from IFC: Creating Markets in Madagascar. Private Sector Diagnostic, 2021. Available at: https://wbgeconsult2.worldbank.org/wbgect/download?uuid=31e955b4-7aae-4b2c-9685-c3bdb613e044

employment. As it did around the globe, tourism in Madagascar declined sharply due to COVID-19, but it has the potential to play a major role in post-pandemic recovery. The difficulty will be in ensuring that tourism in the country is inclusive and sustainable, contributing to economic growth while conserving biodiversity.

Protected areas, such as nature preserves and national parks, can offer solutions to biodiversity loss and land degradation as well as successful tourist attractions. While the number of protected areas in Madagascar has increased significantly since the first national parks were created in 1927, many challenges to developing nature-based tourism and conservation in tandem remain. The following actions can address the constraints facing the development of sustainable nature-based tourism:

- *Increase financing for protected area management and operations.* Current funding levels, between US$6 - $8 million annually for the parks managed by Madagascar National Parks, are about a third of those generally considered necessary for a protected area system of Madagascar's size. There is a strong case for increasing the endowment of the Foundation for Protected Areas and Biodiversity of Madagascar trust fund. NGOs and development partners' levels of funding, currently at about US$2 million, could also be increased, both through development projects and expanded operations support, as could direct government funding.
- *Include a broader range of skill development for park management.* Traditionally focused on protection and conservation, education and training programs should be reassessed to increase opportunities in areas such as tourism management, interpretation, investment promotion, marketing, and administration. Management plans for protected areas should integrate tourism planning and action and could identify the required investments to meet and maintain minimum standards.
- *Finalize the legal framework for tourist concessions in protected areas.* The legal framework for concessions inside protected areas remains incomplete and lacks transparency. Tourism operations and activities inside protected areas that could potentially contribute directly to conservation objectives are limited. The finalization of the framework is expected to unlock private investment in protected areas.
- *Re-assess benefit-sharing arrangements with local communities.* The present system lacks transparency and systematic methods for sharing revenue with local communities. Benefit-sharing can include fees and other charges, indirect benefits from employment generation, and public-private partnerships connected with tourism in protected areas. The assessment must balance the modest resources available for operations and management with increased support for local communities.

EMERGING CHALLENGES

Production of waste is increasing, which needs to be managed through investments in collection and processing infrastructure. Much of the waste produced is disposed of in open dumps that, if near water sources, can leach into the ocean. In addition to pollution, open dumping contributes to health risks from pests and fumes from uncontrolled burning. When solid waste accumulates in waterways it can also exacerbate the severity of flooding by blocking drainage channels.

Environmental impact assessment and management plans must support resilient, green, and inclusive development to avoid land degradation and health issues. These assessments need to be made more comprehensive and routine in connection to development plans at all public and private levels.

As nature-based tourism is developed, sustainability must be considered at every level. Tourism can create negative environmental impacts, such as the generation of greenhouse gasses and pollution through transportation services, excessive water use by hotels, and large-scale solid waste generation. Planning and management of sustainability by individual tourism organizations as well as the larger sector will be critical.

CONCLUSION

Green, inclusive, and resilient economic growth in Madagascar cannot be achieved without improved management of Madagascar's natural capital. As discussed in this CEA, integrated landscape management, better leveraging and protection of Blue Economy resources, mindful expansions of nature-based tourism, and management of emerging environmental challenges will play a key role in the push toward sustainable development in tandem with restoring and protecting Madagascar's natural assets.

Photo credit : Michail_Vorobyev/Shutterstock.com

1 OVERVIEW AND OBJECTIVES

1. **Madagascar experienced modest, positive growth in GDP from 2013 until the COVID-19 pandemic, but poverty remains stubbornly high.** Real annual GDP growth averaged 3.5 percent over the 2013 to 2019 period, driven by a small number of sectors, including mining, construction, telecommunications, and financial services. However, Madagascar is the only country in the world not to have known active civil conflict where per capita GDP has declined since 1960.[2] Poverty and malnutrition are widespread. Moreover, the COVID-19 pandemic triggered a collapse in export revenues and private investment resulting in a contraction of GDP by 7.2 percent and of income per capita by 9.8 percent, and an increase in the poverty rate to an all-time high of 80.7 percent in 2021. A drought in southern Madagascar and a series of cyclones have caused further suffering in these regions, which have higher poverty rates than the center and north. Evidence indicates a stronger correlation in Madagascar between real per capita GDP growth and poverty reduction than the average for sub-Saharan Africa, underlying the importance of effective policies for broad based economic recovery and growth. Cross-cutting issues of low productivity growth and spatial inequality, governance, vulnerability to shocks, as well as the rapid growth of Antananarivo, which now accounts for 50 percent of GDP, are key development challenges.

WEALTH ACCOUNTS FOR MADAGASCAR

2. **While there are a number of factors that explain the persistence and increase in poverty rates, part of the explanation lies in how Madagascar's total wealth has evolved over the past few decades.** Total wealth — defined as the sum of natural, produced, and human capital and net foreign assets — in Madagascar increased by 91 percent between 1995 and 2018 (Table 1.2), driven by a rapid increase in human capital, the largest asset category in 2018.

2 World Bank, 2022. Madagascar Systemic Country Diagnostic (SCD) Update.

Table 1.1. Change in Total Wealth for Madagascar Between 1995 and 2018

Millions, constant 2018 USD	1995	2000	2005	2010	2015	2018
Total wealth	115,125	117,718	143,801	183,492	202,669	219,951
Produced capital	19,272	20,157	22,745	32,189	35,640	38,366
Human capital	52,814	59,480	81,272	94,188	108,373	122,051
Natural capital - renewable	49,562	44,160	40,928	62,458	65,885	66,222
Natural capital - nonrenewable	3	1	1	307	538	438
Net foreign assets	-6,525	-6,079	-1,144	-5,650	-7,768	-7,126
Population (millions)	13.5	15.8	18.3	21.2	24.2	26.3

Source: World Bank, 2021. Changing Wealth of Nations: Managing Assets for the Future.

3. **However, because Madagascar's population grew by 94 percent during the same period, total wealth per capita, the measure of sustainability of growth, decreased by 2 percent (Table 1.3).** Produced capital per capita remained mostly constant and human capital per capita increased over the period of 1995 to 2018, and therefore the decrease in total wealth per capita was driven by a decline in natural capital wealth per capita, with natural capital defined as the sum of renewable natural capital and subsoil assets.

4. **The decline in total wealth per capita makes Madagascar one of only 22 countries out of a total of 146 countries for whom wealth per capita decreased between 1995 and 2018.** Within the same period, Madagascar's peer group of countries - Bangladesh, Cambodia, Rwanda, Tanzania, and Uganda - experienced an increase in total wealth per capita, with Bangladesh, Cambodia, and Rwanda more than doubling their wealth per capita. Moreover, among the six countries, Madagascar ranked second highest in terms of total wealth per capita in 1995, but the lowest in 2018 (Figure 1.1).

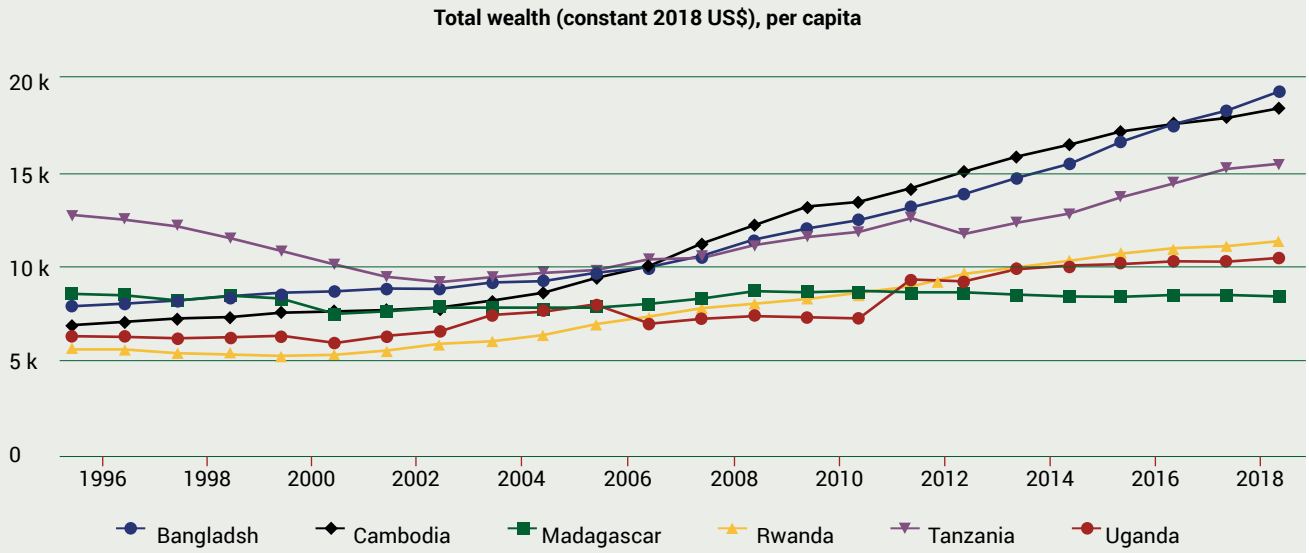
5. **In Madagascar, while subsoil assets per capita increased marginally, renewable natural capital per capita (sum of forest lands, agricultural lands, pasture lands, terrestrial protected areas, mangroves, and fisheries) showed a drop of 31 percent in value from 1995 to 2020.** The country is rich in natural capital with the longest coastline of any African country, substantial fisheries, varied and beautiful coastal ecosystems, unique biodiversity and forests, ample agricultural land, micro-climates suitable for a range of high value crops, and sufficient water resources overall. However, this vast natural capital is not highly productive. Declines in the value of forest ecosystem services[3]-, croplands-, pasturelands- and fisheries-wealth per capita have in fact driven

Table 1.2. Change in Total Wealth per Capital for Madagascar Between 1995 and 2018

Per Capita, constant 2018 USD	1995	2000	2005	2010	2015	2018
Total wealth	8,543	7,466	7,842	8,675	8,363	8,375
Produced capital	1,430	1,278	1,240	1,522	1,471	1,461
Human capital	3,919	3,772	4,432	4,453	4,472	4,647
Natural capital - renewable	3,678	2,801	2,232	2,953	2,719	2,522
Natural capital - nonrenewable	0	0	0	15	22	17
Net foreign assets	-484	-386	-62	-267	-321	-271

Source: World Bank, 2021. Changing Wealth of Nations: Managing Assets for the Future.

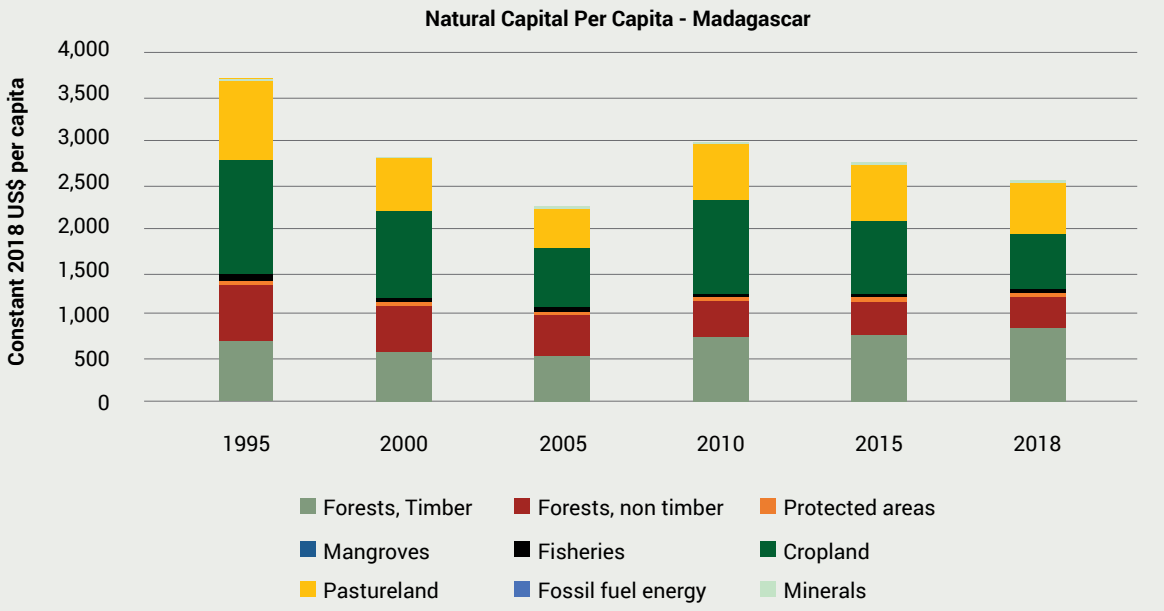
Figure 1.1. Total Wealth per Capita Trends in Madagascar and Peer Countries from 1995 to 2018



Source: The Changing Wealth of Nations, 2021. Managing Assets for the Future, Washington D.C.: World Bank.

a decline in natural capital wealth (Figure 1.2). While per hectare value of forest ecosystem services increased between 1995 and 2018, total forest area declined, and combined with high population growth this led to a decrease in forest ecosystem services wealth per capita. For fisheries, while catch increased during the period studied, rents showed a consistent decline. Low productivity of the country's natural asset base, therefore, in large part drove the decline in total wealth per capita, contributing to the lack of economic growth and poverty reduction.

Figure 1.2. Change in Natural Capital Wealth per Capita for Madagascar Between 1995 and 2018



Source: World Bank. 2021. Changing Wealth of Nations: Managing Assets for the Future.

3 Three ecosystem services are included in Changing Wealth of Nations: recreation, non-wood forest products, and water services.

ROLE OF NATURAL RESOURCES AND ENVIRONMENT IN THE ECONOMY

6. **Agriculture, production forestry and fisheries are dominant economic sectors but face constraints to productivity growth.** These sectors account for approximately 25 percent of GDP and 75 percent of employment. However, there has been little productivity growth in these sectors between 2013 and 2019. About 1.1 million hectares in the country are equipped for irrigation infrastructure,[4] but much agricultural production still takes place at a semi-subsistence level with limited access to inputs and "slash and burn" technologies which contribute to deforestation and soil erosion. Moreover, the sector is vulnerable to drought, cyclones, and locust infestations. There is potential for increasing productivity and for value chain creation, but growth in agri-business is also severely constrained by inadequate road infrastructure and connectivity, poor access to electricity, and a difficult business environment.[5] Nonetheless, Madagascar has a long-established export industry in selected high value agricultural products, which include vanilla (approximately 26 percent of export value), essential oils and cloves (7 percent) and seafood products (5 percent).[6] The Ministry of Agriculture and Livestock has overall oversight for this sector.

7. **Madagascar's natural forests, comprising about 21 percent of land area, provide key ecosystem services but are under threat.** Madagascar's forests play a key role in watershed protection and in nature and biodiversity conservation, provide timber and non-timber forest products, and are the principal source of energy for cooking. Protected areas form 12 percent of land area; Madagascar harbors unique biodiversity both inside and outside protected areas but especially within forests. It is estimated that 90 percent of plants and 85 percent of animal species are endemic.[7] Deforestation and related degradation of forest, grazing, and agricultural lands contribute to erosion rates that are among the highest in the world, and to downstream flooding. The Ministry of Environment and Sustainable Development has oversight for forestry, while Madagascar National Parks, which manages protected areas, also reports to the Ministry. In addition to the aforementioned ministries, the Ministries of Land Development and Land Administration and the Ministry of Interior and Decentralization, also play important roles in land management.

8. **Madagascar has substantial water resources, but spatial distribution is uneven.** Annual average rainfall is 1500 mm per year, and total annual renewable water resources are estimated at 13,000 m^3 per capita.[8] 11 percent is withdrawn for economic use, mostly for irrigation, which accounts for 96 percent of water withdrawals. However, the south is relatively water stressed and drought prone and lacks rivers with perennial flows, while the center and north are subject to periods of extreme rainfall, flooding, and gully erosion. Current agriculture and rice cultivation management methods have contributed to deteriorating water quality and loss of wetlands. Madagascar has substantial hydro-electric power generation potential but progress with ongoing investments is slow, partly for governance related reasons, including delays in finalizing contracts.[9] The Ministry of Water, Sanitation, and Hygiene includes the Directorates for Integration of the Environment and Water Resource Management and is in charge of the country's water resources.

9. **With 5,600 kms of coast Madagascar has substantial fisheries resources and varied and beautiful coastlines.** Its Exclusive Economic Zone (EEZ) extends to more than 1 million km^2; in 2018 fisheries accounted for almost 7 percent of GDP[10] and supported the livelihoods of 1.5 million people. However, overfishing, harmful fishing practices, and destruction of marine habitat have

4 World Development Indicators. Available at: https://databank.worldbank.org/source/world-development-indicators

5 World Bank, 2022. Madagascar Systemic Country Diagnostic (SCD) Update.

6 Lloyds Bank, 2021. Foreign Trade Figures in Madagascar. Available at: https://www.lloydsbanktrade.com/en/market-potential/madagascar/trade-profile

7 Duke Lumur Center. Madagascar: A Biodiversity Hotspot. Available at: https://lemur.duke.edu/8-20-ll1/#:~:text=Because%20Madagascar%20has%20been%20an,85%25%20of%20animals%20are%20endemic

8 USAID, 2021. Madagascar Water Resources Profile Overview. Available at: https://winrock.org/wp-content/uploads/2021/08/Madagascar_Country_Profile-Final.pdf

9 U.S. Department of State, 2021. 2021 Investment Climate Statements: Madagascar. Available at: https://www.state.gov/reports/2021-investment-climate-statements/madagascar/

10 World Bank, 2020. Madagascar: Balancing Conservation and Exploitation of Fisheries Resources. Available at: https://www.worldbank.org/en/news/feature/2020/06/08/madagascar-balancing-conservation-and-exploitation-of-fisheries-resources#:~:text=The%20fishery%20sector%20plays%20a,6.6%25%20to%20the%20total%20exports

played a role in the decline of fisheries. Monitoring and methods for assessing sustainable yield are lacking. The Ministry for Fisheries and Blue Economy has broad oversight for the sector, but other government agencies and the private sector also play a role.

10. **Tourism, a key sector of the economy, is dependent on Madagascar's coastlines, the marine environment and unique terrestrial biodiversity.** The sector recovered during the 2013 to 2019 period. By 2019, its total (direct and indirect) contribution to GDP was estimated at 12.7 percent,[11] and 9.9 percent of employment. Most tourists stay two weeks or more and over 60 percent visit at least one protected area, though the majority of visits are concentrated in only six relatively accessible parks. Poor infrastructure remains a constraint to growth. The sector was deeply impacted by the COVID-19 pandemic - its total contribution to GDP fell to only 4.4 percent and 6.9 percent of employment in 2020 (WTTC, 2021). The Ministry of Tourism has overall oversight for the sector.

11. **Madagascar has persistent and emerging environmental challenges which result in large health impacts and imposes heavy economic and social costs on the economy.** The 2013 Madagascar Country Environmental Analysis (CEA)[12] included an estimate of the economic costs of environmental degradation. These totaled over 9 percent equivalent of GDP annually. The principal contributors were *unsafe water supply and lack of sanitation, and indoor air pollution* from burning solid fuel (both of which have health impacts), followed by cropland and soil degradation, natural disasters, and deforestation. These costs to the economy are likely to persist as the underlying environmental and natural resource challenges persist. Fuelwood and charcoal are still the principal source of cooking fuel for over 90 percent of households. Costs may also likely be higher as the previous report did not account for the economic burden from time spent, largely by women, in collecting fuelwood, or the costs of forest degradation (in addition to deforestation). **Ambient air pollution** is an emerging issue as is **solid waste management (SWM)**. Management of environmental impacts of the tourism sector and other development projects, such as infrastructure development, also remain relevant. Currently environmental management responsibilities sit within the Ministry of Environment and Sustainable Development.[13] The National Environment Office (ONE) is responsible for collection and monitoring of environmental data, environmental regulations, and environmental impact assessment.

CLIMATE CHANGE CHALLENGES

12. **Madagascar is highly exposed to climate risks, and these are being exacerbated by climate change.**[14] The country experiences an average of three to four cyclones per year, which cause widespread coastal flooding, loss of life, and damage to infrastructure and livelihoods. Inland heavy rainfall also contributes to gully erosion, flooding in urban areas, and loss of connectivity. Conversely, Parts of the country, especially in the south, are highly vulnerable to drought, which contributes to loss of crops and widespread hunger and malnutrition, while the west is particularly vulnerable to erosion. Coastal erosion is also ongoing. These impacts are expected to become more severe over the course of the century due to climate change.

13. Nevertheless, **Madagascar has a small greenhouse gas emissions footprint.** Emissions were estimated at approximately 57 million tons of CO2e in 2011, equivalent to 2.65 tons CO2e per capita.[15,16] Emissions are dominated by land use, land use change and forestry (57 percent) and agriculture (41 percent), which together contributed 98 percent of total GHG emissions.

11 World Travel and Tourism Council, 2021. Madagascar: 2021 Annual Research, Key Highlights. Available at: https://wttc.org/Research/Economic-Impact/moduleId/704/itemId/153/controller/DownloadRequest/action/QuickDownload

12 World Bank, 2013. Madagascar Country Environmental Analysis: Taking Stock and Moving Forward. World Bank, Washington, DC. Taken from Chart 4. Available at: https://openknowledge.worldbank.org/handle/10986/33934

13 Republic of Madagascar, 1997. Updated in 2020. Decree No. 2020-206. Available at: https://www.environnement.mg/wp-content/uploads/2020/09/ORGANIGRAMME-MEDD.pdf

14 Climate Change Knowledge Portal. Madagascar Country Profile. Available at: https://climateknowledgeportal.worldbank.org/country/madagascar/vulnerability

15 Climate Watch, 2020. GHG Emissions. Washington, DC: World Resources Institute. Available at: climatewatchdata.org/ghg-emissions

16 WDI has much lower emissions figures (0.14 CO2E per capita in 2018) available at: https://data.worldbank.org/indicator/EN.ATM.CO2E.PC?locations=MG but not including LULCF or agriculture. Overall, data and monitoring systems are in their early stages of development in Madagascar.

14. **Madagascar's Nationally Determined Contribution[17] (NDC) submitted to the UNFCCC in September 2016,[18] emphasized that the country's priority is resilience and adaptation.** Adaptation measures include multi-hazard early warning systems, climate resilient agriculture, livestock, fisheries and mangrove restoration, water resource management, coastal protection, ecosystem-based adaptation, and restoration of natural habitats. The NDC stated that Madagascar intends to reduce its GHG emissions by 14 percent by 2030 compared to Business as Usual, conditioned on financial support from the international community. Proposed mitigation actions include reforestation, enhanced forest and grassland monitoring, climate-smart rice farming techniques, increased hydropower and solar energy, sustainable cook-stoves, and energy efficiency. Many proposed actions contribute to both adaptation and mitigation. Policy and actions on climate change are coordinated by the National Bureau for Climate Change.

OBJECTIVES AND SCOPE OF THE CEA

15. **Madagascar faces many environmental, natural resource management, and climate change risks that are impeding development and need to be addressed.** Tackling the multiplicity of environment, natural resources, and climate change risks in the context of numerous development challenges, limited financial resources and governance issues is challenging. Yet, given the dependence of people and the economy on sustainable natural resource management, and the costs of environmental degradation, it is essential that these challenges be addressed for Madagascar to achieve green, resilient and inclusive economic growth.

16. **The Government of Madagascar's strategy for economic growth, 2019 - 2023 Plan Emergence de Madagascar (PEM), recognizes the need for sustainable management and conservation of natural resources.** The PEM presents a longer-term vision up to 2030 and comprises four pillars: good governance, human development, economic development, and the environment. Under Objective 13, the Malagasy government aims to 'Preserve Natural Resources and the Environment', and 'Promote Blue Economy', among other areas of focus.[19] To 'Preserve Natural Resources and the Environment', PEM sets out priority actions including establishing green infrastructure networks to promote resilience to risks and disasters, promoting reforestation actions, scaling up landscape and forest restoration, coordinating different options for developing forest resources, and promoting value chains from natural resources. To 'Promote Blue Economy', priority actions include strengthening the Fisheries Surveillance Center (**Centre de Surveillance des Pêches,** CSP), creating dedicated landing sites and rescue stations in all selected ports, placing luminous beacons on wrecks, and modernizing the port of Toamasina and rehabilitating secondary ports.

17. **The CEA aims to deepen knowledge of natural resources and environmental challenges and their development impacts, highlight opportunities for Green, Resilient, and Inclusive Development (GRID) with the purpose of informing government policies and programs, and World Bank engagements.** With an emphasis on improving the productivity of natural capital, the CEA is structured as follows:

    (i) Identification of opportunities to promote green, resilient, and inclusive growth, with a focus on sustainable landscape management, the Blue Economy, and nature-based tourism (Chapters 2, 3, and 4, respectively),

    (ii) Analysis of environment sector challenges, institutions and governance frameworks (Chapter 5); and

    (iii) Identification of environment-development priorities, and actionable recommendations for the country (Chapter 6).

18. **The CEA does not, however, address climate change in depth to keep the scope manageable.** Many of the recommendations of the CEA will be relevant to resilience and mitigation issues, which will be developed in the upcoming Country Climate and Development Report.

17 Government of Madagascar, 2016. Available at: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Madagascar%20First/Madagascar%20INDC%20Eng.pdf

18 The 2016 NDC is under review and an updated NDC is yet to the submitted.

19 Initiative Emergence Madagascar, 2018. Available at: http://iem-madagascar.com/

Box 1.1. Integration of the Focus Areas of the Madagascar CEA with the Key Pillars of the PEM 2023

The CEA seeks to directly address eight of the thirteen objectives highlighted in the PEM. Under the governance pillar, recommendations support increased empowerment at decentralized level; under the human development pillar, recommendations support improved health and urban development; under decent jobs and the more rapid and inclusive sustainable growth pillar, recommendations support development of the tourism industry and food self-sufficiency; and under the environment pillar, recommendations support access to clean energy and water for all, and sustainable management and conservation of natural resources.

Pillar	Objectives	Direct Link with CEA
Good Governance	1: Peace and security	….
	2: Zero tolerance of corruption	…..
	3: Increased autonomy in decision-making for decentralized authorities	Yes
Human Development: "Hiadana Syo Finaritra"	4: Education for all	…..
	5: The right to good health	Yes
	6: Decent jobs for all	Yes
	7: Housing and modern urban development	Yes
	8: Sport and culture as a basis for national pride	…..
More Rapid, Sustainable and Inclusive Economic Growth	10: Industrialization	….
	11: Development of the tourism industry	Yes
	12: Food self-sufficiency	Yes
Environment	9: Energy and water for all	Yes
	13: Sustainable management and conservation of natural resources	Yes

Photo credit : Natia Tsiky

2

INTEGRATED LANDSCAPE MANAGEMENT

STATUS OF MADAGASCAR'S LANDSCAPES

19. **Madagascar's forest area has declined from 29 percent of land-area in 2000 to 21 percent in 2020 (Figure 2.1).**[20] Deforestation during this period was particularly acute in the southwestern regions of Menabe and Atsimo Andrefana and in the northwest Sofia region, where in some districts nearly half of the remaining forest was converted to cropland and/or grazing land (e.g., Belo Sur Tsiribihina, Morondava, Manja, Morombe, Ankazoabo, and Port-Berge).

20. **Madagascar's landscapes have been subject to degradation for decades.** There has also been widespread degradation across principal land uses – including forestlands, agriculture lands, and grazing lands. Quantifying land degradation using a composite index based on four key indicators — vegetation health (measured using the normalized difference vegetation index[21]: NVDI), land productivity (measured by net primary productivity[22] (NPP), soil retention capacity and dry season water flow[23] — suggests that roughly *35 percent of the country's land area has been degrading over the last 30 years* (Figure 2.2). Degradation has been particularly severe in the western region (especially Menabe and Bongolava, along with parts of Itasy, Vakinankaratra, Amoron'i Mania, and Haute Matsiatra) and southwestern region (Atsimo Andrefana, Ihorombe, Anosy, and parts of Androy). There are also hotspots of land degradation in Boeny, Melaky, and Alaotra Mangoro. On the other hand, northern regions of Diana and Sava saw improvements in land quality.

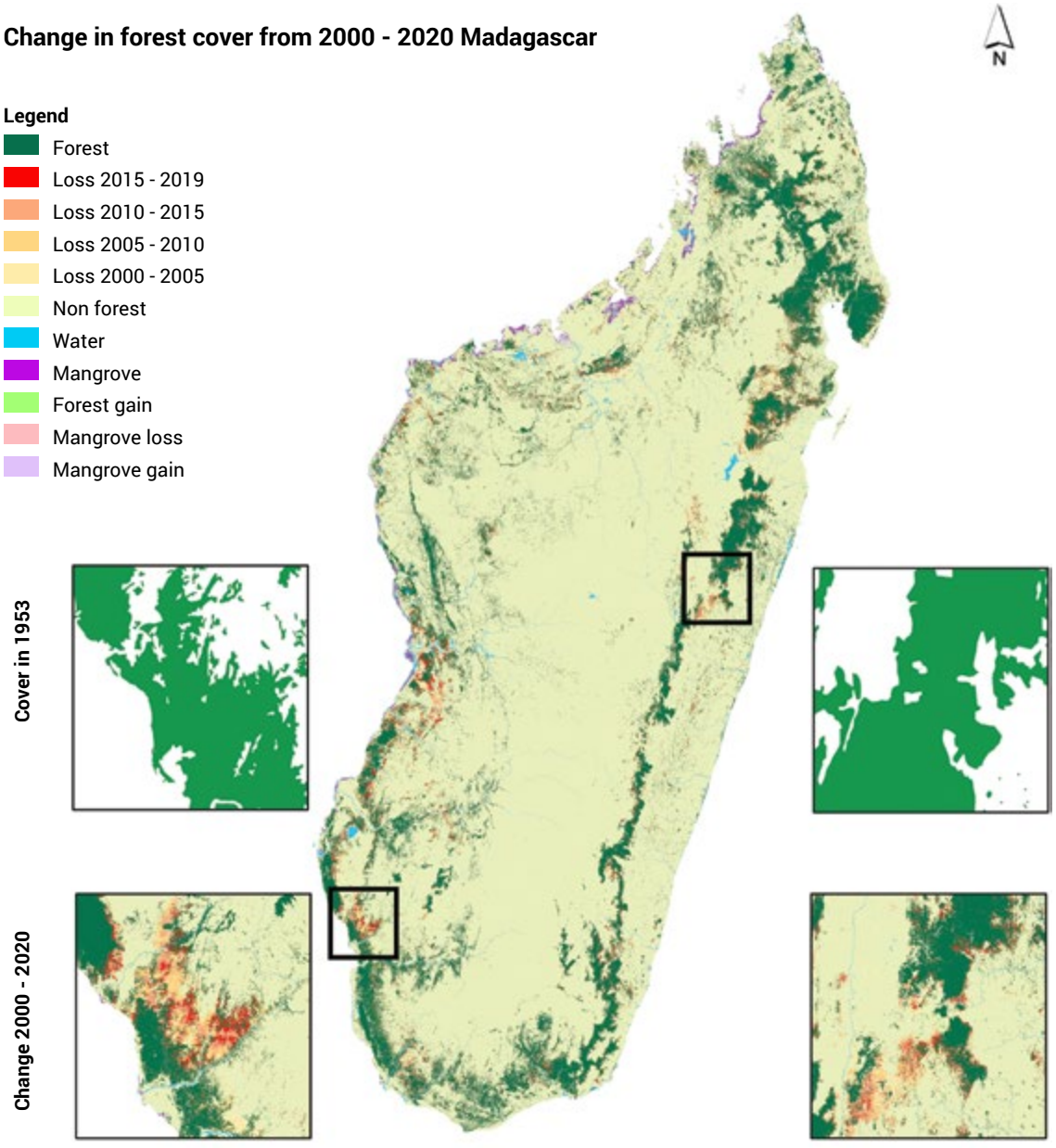
20 Global Forest Watch. Madagascar Country Profile. Available at: https://www.globalforestwatch.org/dashboards/country/MDG/?category=forest-change&location=WyJjb3VudHJ5IiwiTURHIl0%3D&map=eyJjZW5

21 Normalized Difference Vegetation Index (NDVI) quantifies vegetation by measuring the difference between near-infrared (which vegetation strongly reflects) and red light (which vegetation absorbs). Overall, NDVI is a standardized way to measure healthy vegetation. High NDVI values indicate healthier vegetation.

22 Net primary productivity is a measure of plant growth; it indicates how much carbon dioxide vegetation takes in during photosynthesis minus how much carbon dioxide the plants release during respiration.

23 The latter two were modeled using the InVEST suite of tools along with data on soils, topography, climate, and land cover and management.

Figure 2.1. Forest Cover Change Between 2000 and 2020 in Madagascar

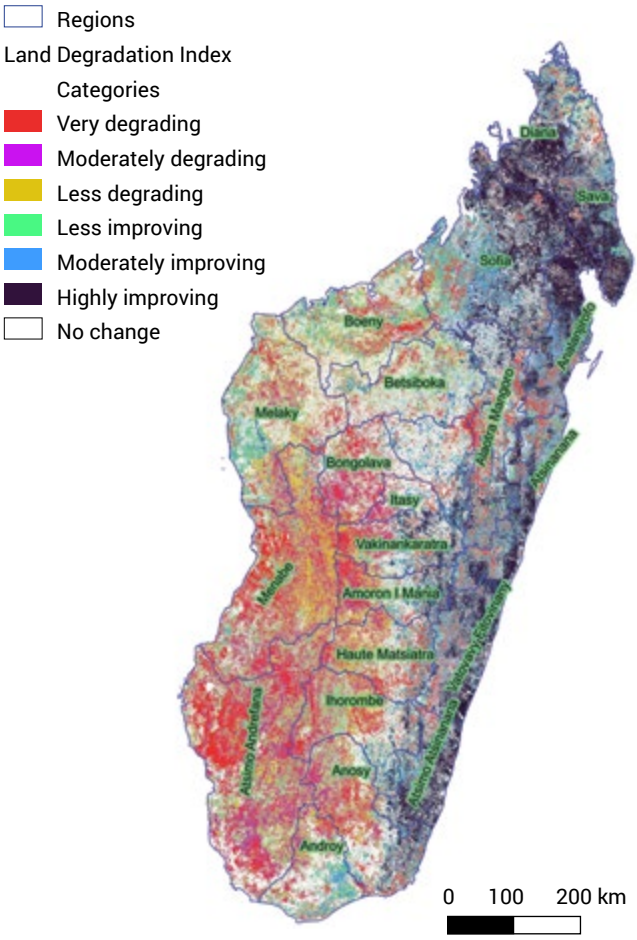


Source: World Bank team estimation based on data from LOFM, 2022.

21. **Land degradation also took place in protected areas.** Unique landscapes experiencing severe degradation included Ambararata Londa and Analavelona in northern Madagascar (99 percent and 97 percent of land area degraded, respectively), the Alliances des Baobabs (98 percent area degraded), the Complexe Lac Forest Ambondrobe (63 percent area degraded) and the Complexe Zones Humides Mangoky Ihotry in western Madagascar (49 percent area degraded). Some protected areas, primarily in the north, experienced an improvement in land condition over the last 30 years, including COMATSA Su, Mahimborondr, Bemanevika, and the Complexe des AP Ambohimirahavavy Marivorahona.

22. **The cost of land degradation over the 30-year period is estimated at over USD $6.7B, which amounts annually to a cost equivalent to 1.78 percent of GDP per year.** This is a conservative estimate that only considers lost yields of main crops due to erosion, lost energy production due to declining water availability for hydropower, the potential cost of dredging reservoirs, and the

Figure 2.2. Land Degradation Trends in Madagascar 1990 – 2020



Source: World Bank Team Estimation.

opportunity cost of unrealized carbon credits on the international market.[24] If the global social cost of unrealized carbon absorption is considered, the cost of degradation in Madagascar is over USD $8.1B, equivalent to 2.15 percent of GDP per year.[25]

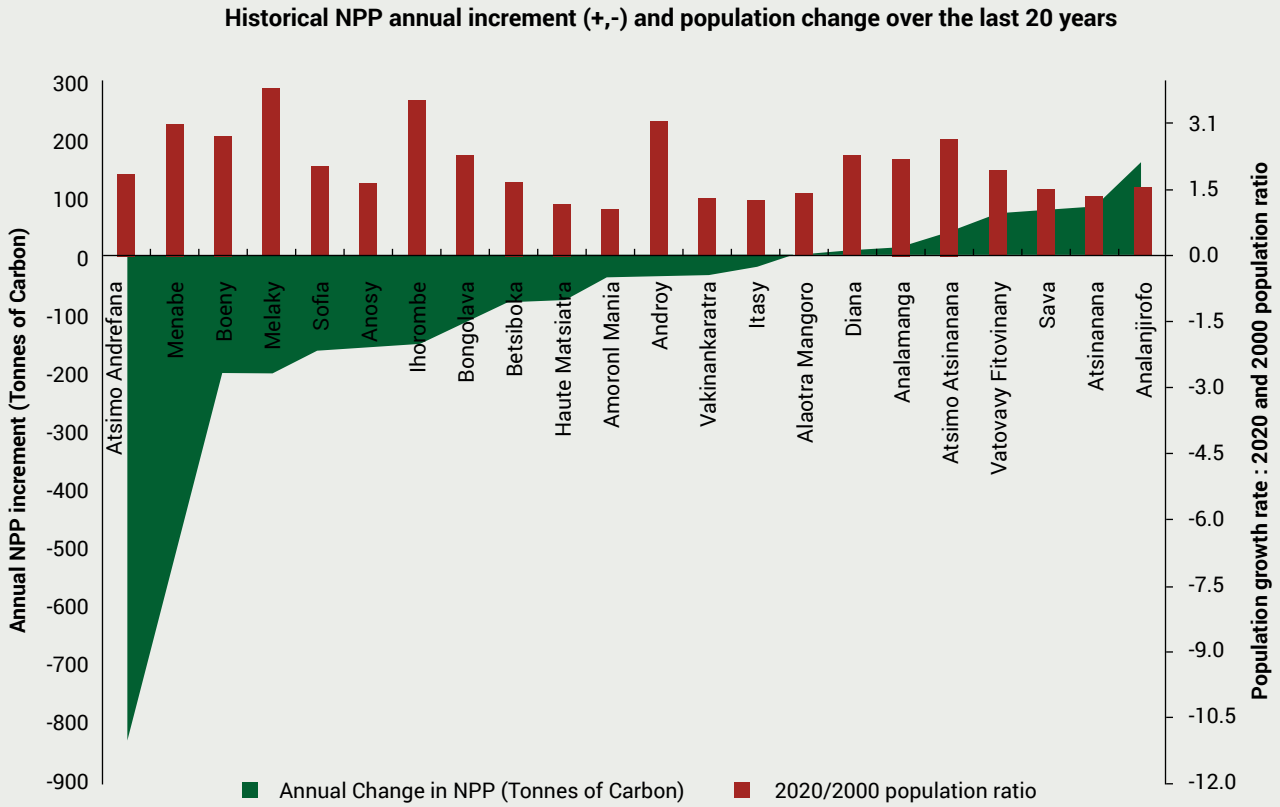
23. **Land degradation threatens food security, and biofuel and fodder availability.** Net primary productivity (NPP), a measure of plant growth, showed a declining trend in 43 percent of the land area. In the last two decades, 14 of 22 regions recorded an annual negative increment in NPP. Areas hardest hit in many cases corresponded to areas with the highest population increases (Figure 2.3). Eighteen districts, including many in the southwestern region and Igonko in the southeast, tripled their population in the last 20 years while their NPP shows a declining trend. Some northern districts in Sava (Vohemar) and Diana (Antsiranana II, I) also show declines in productivity, despite the increasing rainfall recorded over the same time period and generally increasing trends in NPP in those regions. These declines in productivity reflect both declining crop productivity and the rural population's access to biofuel and fodder resources. Losses in crop production due to erosion and land degradation over the 30-year period are estimated at US$4.1B, with a yearly average of US$141.4 million equivalent to 5 percent of agricultural GDP. In regions of high erosion and agricultural importance the impact is especially important. Haute Matsiatra, for example, suffered crop yield loss due to land degradation equivalent to over US$500 million over the last 30 years. The southern regions of Atsimo Andrefana, Androy, Anosy, and Ihorombe lost 27 percent of remaining forest cover since 2000, and 54 percent of land area has been degrading since 1990. This combination of deforestation and land degradation has resulted in over US$240 million in losses to the agricultural sector in this region. The livestock sector has also been affected. While some districts, primarily in the central regions, have seen improvements in productivity in grazing areas, much of the southwest, northwest, and northern Diana region show a decline in grazing land productivity (Figure 2.4).

24. **Land degradation reduced the capacity of the land to store water, leading to water scarcity.** Madagascar is water abundant overall, but national annual water yield has declined from 346,000 to 280,000 M m^3 since 1990, mostly because of declining rainfall, but also in part because changes in land use and declining vegetation cover have reduced landscapes' ability to capture and store rainfall, increasing storm runoff and the potential for more flooding. While the north has seen increasing water availability, the south and southwest have seen declines of over 50 percent, increasing water scarcity in this already drought-prone region.

24 This is a partial estimate as it leaves aside sectors that are also affected by the depletion of natural capital, for example tourism, and some crops due to data limitations.

25 UNCCD (2018) measured the Total Economic Value of ecosystem services, that include values that are not part of GDP estimation and found much higher values for land degradation - 23% of annual GDP. UNCCD, 2018. Madagascar Country Profile. Investing in Land Degradation Neutrality: Making the Case. An Overview of Indicators and Assessments.

Figure 2.3. Changes in Land Productivity and Population Growth by Regions (based on analysis of annual net primary productivity, NPP)



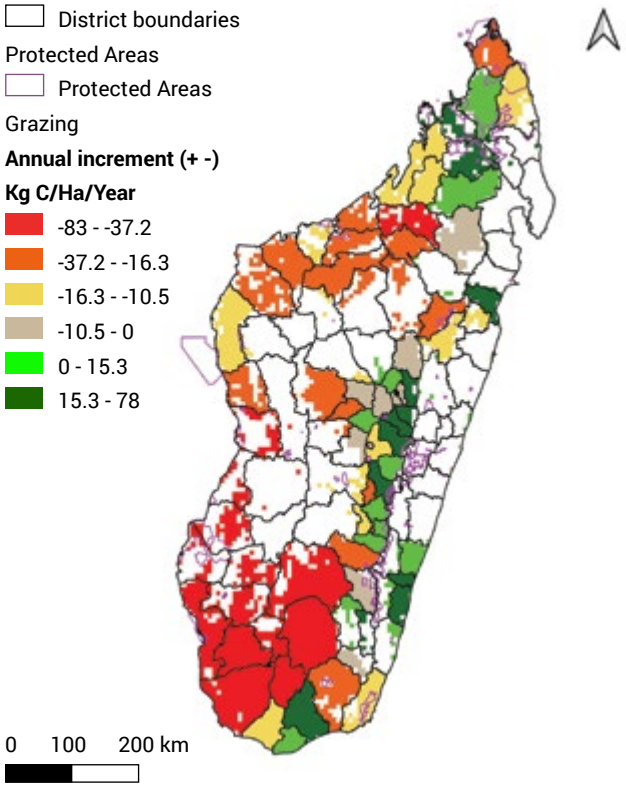
Source: World Bank Team Estimation.

25. **Land degradation and erosion also adversely impact reservoirs constructed for hydropower and irrigation.** Sediment loads from erosion upstream of dams have reduced their usable storage and capacity to generate electricity or deliver water for irrigated agriculture. Erosion also fills irrigation channels and reduces the effectiveness of irrigation infrastructure. Figure 2.5 illustrates the impacts on a number of key facilities: the Andekaleka dam, for example, has 91 MW of installed capacity, but sedimentation has increased by 61 percent while its water yield has declined by 34 percent. As a consequence, the dam, which provides 71 percent of the generation for the Antananarivo Interconnected Network, has suffered losses in power generation of US$109 million since 1992. Dredging its reservoir of accumulated sediments would have cost US$158 million. The situation is similar for irrigation dams: A study by the World Bank estimated the costs to irrigated agriculture of sedimentation of the Amboromalandy dam at US$13.8 million annually, while other calculations yield an annual cost of US$9.8 million for potential dredging costs. Riverbank erosion also contributes to the severity of downstream flooding, leading to loss of homes and urban infrastructure.

INTEGRATED LANDSCAPE MANAGEMENT: MAKING THE CASE

26. **Historically siloed approaches to rural development have had limited success.** Three key rural sectors – agriculture, water, and forests – have traditionally approached challenges of agricultural production, irrigation and water provision, and forestry/biodiversity conservation independently. Such approaches often did not achieve their objectives of rural development, improved livelihoods, or protection of the

Figure 2.4. Trend of Fodder Productivity in Grazing Areas over the 30-year Period (based on analysis of annual net primary productivity, NPP)

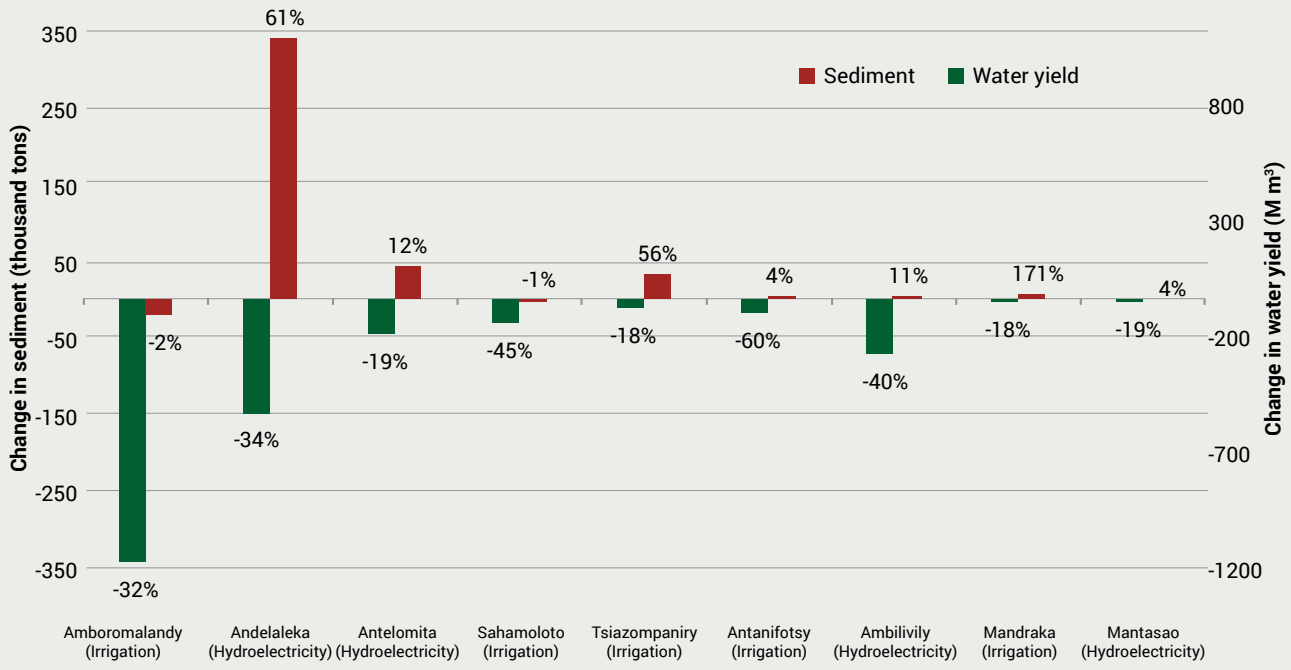


Source: World Bank Team Estimation.

environment, because they failed to account for the multi-functionality and diversity of demands on the landscapes. Improving the productivity of the agriculture sector requires addressing forest and non-agricultural land management, both of which contribute to soil loss. Similarly, it will be harder to fight against deforestation and loss of biodiversity with the continued dependence of rural households on traditional forms of slash and burn agriculture — a leading cause of forest and land degradation — along with the dependence of 99.3 percent of Madagascar's population on fuelwood or charcoal for cooking.

27. **There has been increasing recognition of the need to adopt an integrated landscape management approach to rural development.** This involves supporting forests and natural ecosystems, agriculture and water resources development in ways that sustain the natural resource base, recognizing interactions throughout watersheds, enhancing ecosystem functions and livelihood resilience and adopting a people-centric and economy-led approach.

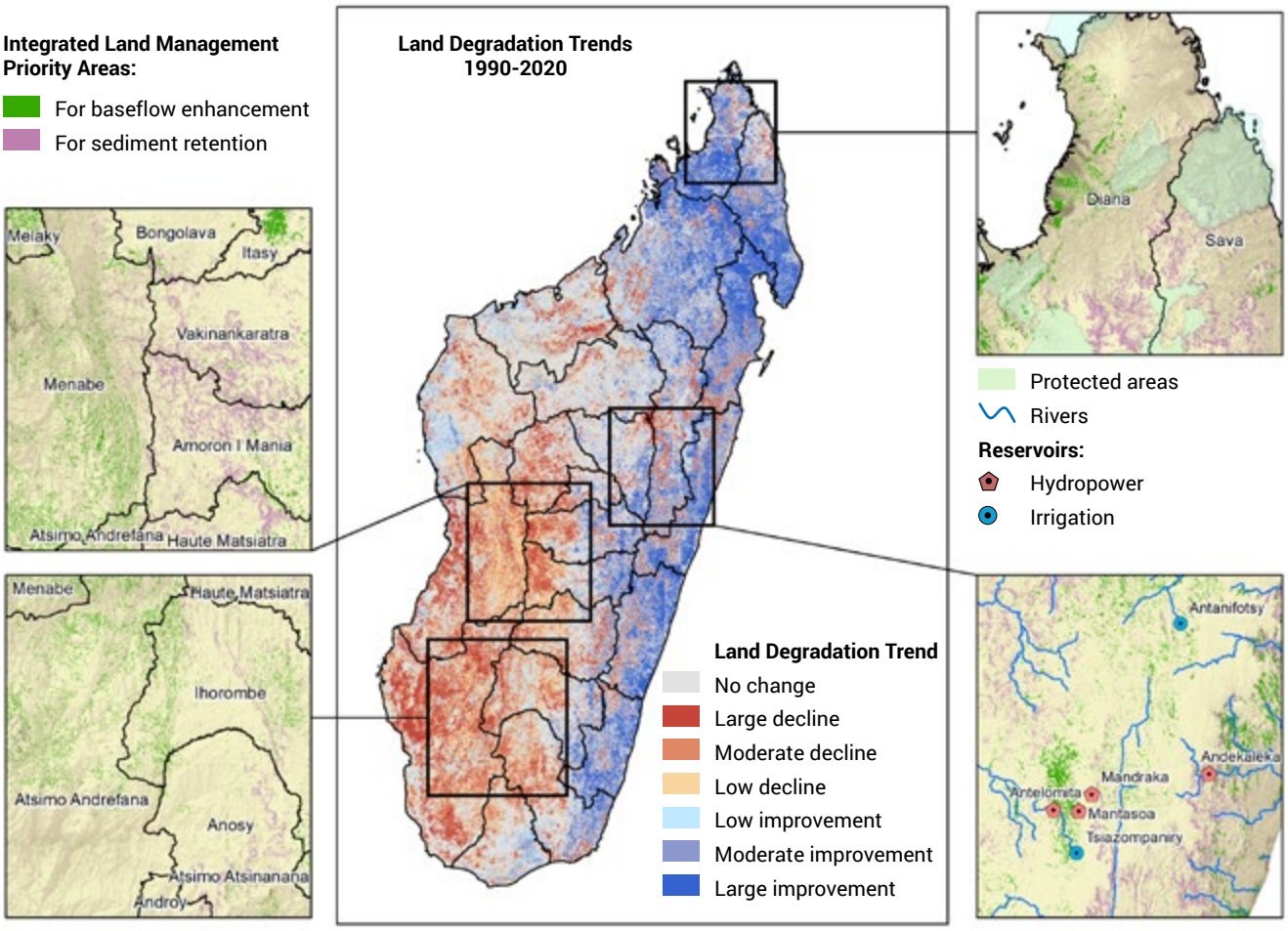
Figure 2.5. Land Degradation Impacts on Water Yield and Sedimentation for Major Irrigation and Hydropower Dams



Source: World Bank Team Estimates

28. **Integrated landscape management can, in many parts of the country, reverse land degradation and restore ecosystem services** such as erosion control, water regulation and purification, flood mitigation, carbon storage, and biodiversity. Figure 2.6 shows areas where land degradation (Figure 2.6, center) coincides with places where investments in nature-based solutions can simultaneously enhance erosion control and water regulation (Figure 2.6, right and left panels). Integrated land management programs that incorporate activities and priorities from agriculture, water, and forest- can work together in these areas to improve the flow of these ecosystem services. Improving landscape conditions through implementation of these measures is estimated to bring benefits of US$46 million annually to the agriculture sector. Regions with the highest potential benefits to agriculture productivity on an annual basis include Sofia (US$7.4 million) Itasy (US$7.2 million), Alaotra Mangoro (US$5.0 million), Analamanga (US$4.9 million), and Boeny (US$3.4 million).

Figure 2.6. Land degradation trends (center), and examples of priority land areas where Integrated Land Management (ILM) can enhance baseflow and reduce soil erosion in highly degraded lands (left) and protected areas (upper right) and improve the lifespan of reservoirs (lower right).



Source: World Bank Team Estimation.

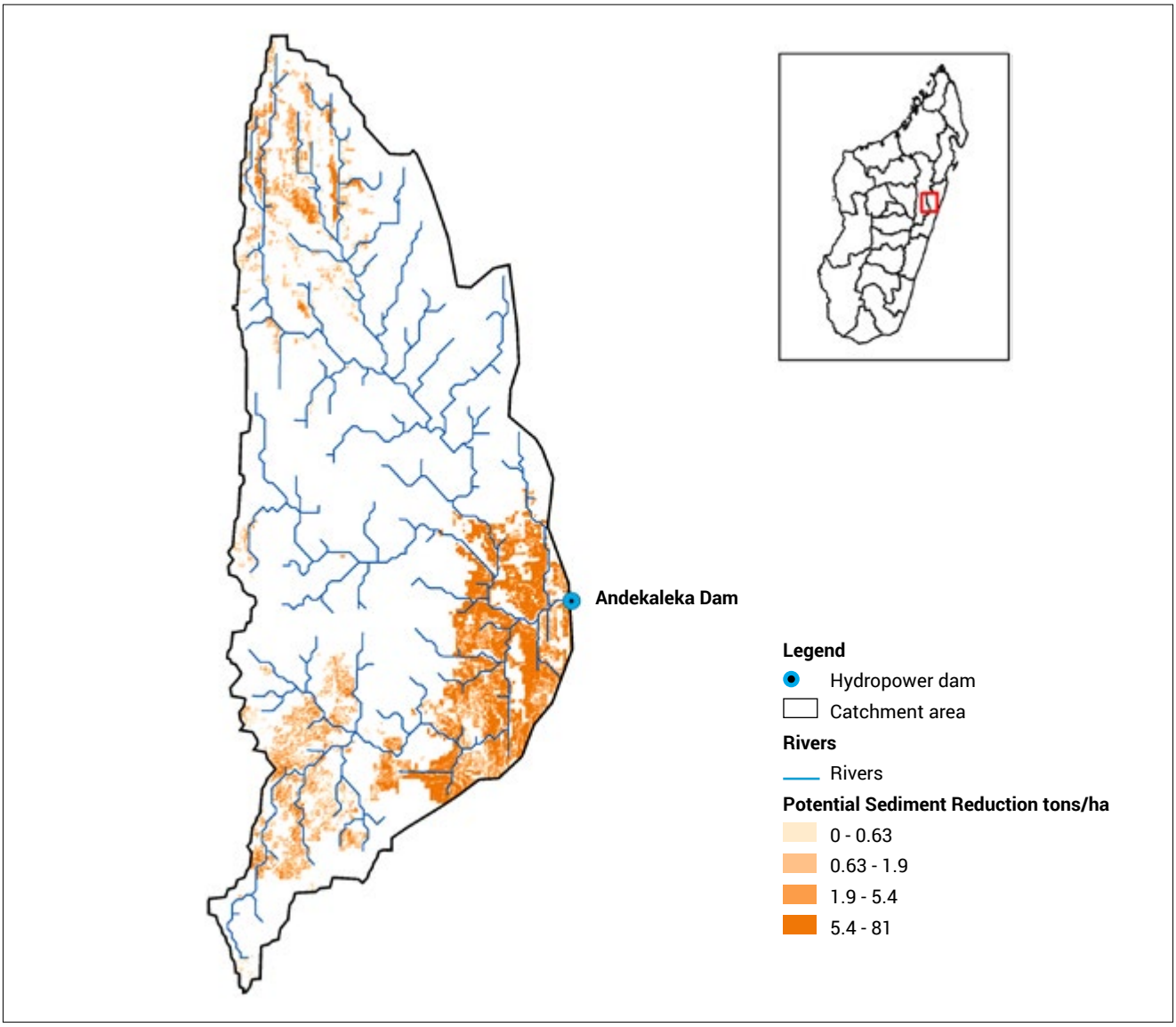
Note: Priority ILM areas highlighted in the thumbnail maps are those with the highest potential for integrated landscape management to control erosion and improve dry season streamflow within the given area. Scores are calculated using the InVEST[26] sediment and seasonal water yield models under 2020 baseline conditions and a scenario where integrated landscape management is implemented to improve vegetation and soil health in croplands, grazing lands, and other degraded areas.

26 Sharp, R., Douglass, J., Wolny, S., Arkema, K., Bernhardt, J., Bierbower, W., Chaumont, N., Denu, D., Fisher, D., Glowinski, K., Griffin, R., Guannel, G., Guerry, A., Johnson, J., Hamel, P., Kennedy, C., Kim, C.K., Lacayo, M., Lonsdorf, E., Mandle, L., Rogers, L., Silver, J., Toft, J., Verutes, G., Vogl, A. L., Wood, S, and Wyatt, K, 2020. InVEST 3.9 User's Guide. The Natural Capital Project, Stanford University, University of Minnesota, The Nature Conservancy, and World Wildlife Fund.

29. **Controlling sedimentation through investing in better land management can make hydropower more resilient.** As noted, land degradation has resulted in higher discharge of sediments and a lower reliability of water availability from watersheds that feed the reservoirs of some of the most important hydropower plants in Madagascar. Yet there is potential to significantly decrease sedimentation by 324,000 tons/year (36 percent reduction) by implementing soil and water conservation practices in the catchment area (Figure 2.7), saving an estimated US$1.3 million annually in dredging costs. Improved land management in the Alaotra Mangoro and Analamanga regions, in addition to the agriculture sector benefits listed above, would also benefit the existing major hydropower dams in the country, with a total savings of US$1.8 million in avoided yearly costs.

30. **Implementation mechanisms for integrated landscape management can vary** but are expected to use broad stakeholder participation, conflict management, negotiation around objectives and strategies, and adaptive management based on shared learning.

Figure 2.7. Potential Sediment Reduction to the Andekaleka Hydropower Dam from Implementing Improved Land Management Practices, Primarily in Croplands and Grazing Lands



Source: World Bank Team Estimation

IMPLEMENTING ILM: ADDRESSING TENURE AND GOVERNANCE CHALLENGES

Land and Forest Tenure Challenges

31. **Land and forest tenure is a key aspect of integrated landscape management.** Effective and sustainable landscape management implementation relies on the inclusive and consensual design of the land use planning, and the capacity of stakeholders to ensure that assigned land use would be maintained over time. For this purpose, clarifying and securing tenure appears to be a prerequisite. The formalization of land rights is expected to lead to increased agricultural investments (especially at the local level), improving yields and generating larger incomes, reduce conflicts over land and resources, and contribute to securing the property rights of vulnerable households and women.[27]

32. **Madagascar led an innovative reform of its land tenure system in 2005 with the aim of democratizing land ownership.** Since colonial rule, the land tenure system assumed that all land belonged to the state (the presumption of state ownership, *"présomption de domanialité")* except for private land with a title issued by the state land services.[28] Obtaining land titles was (and remains) cumbersome, time-consuming, and expensive, and therefore out of reach of rural populations who relied on customary ownership, based on de facto occupation and development of land. This dualism in land ownership, combined with population growth and increasing demand for land, contributed to widespread land insecurity. In 2005, a major land reform was launched to allow more citizens, especially farmers and rural populations, to obtain legal recognition of their land rights. Law 2005-019 on land status replaced the presumption of state ownership with the presumption of ownership *("présomption de propriété")* and created a new land status: untitled private land property *("propriétés foncières privées non titrées",* PPNT) governed by law 2006-031. Plots of land that have been developed by farmers can be titled by a written document – the land certificate – issued by the commune. The process is coordinated by local land offices *("guichets fonciers")* opened in rural municipalities.

33. **The land reform has the potential to yield significant development gains, but its implementation remains slow.** By 2021, 16 years after the reform, 520,000 land certificates had been issued through local land offices and 300,000 files were being processed. However, despite these ongoing efforts to modernize and decentralize land administration, fewer than 8,000 formal land titles are issued per year and around 10 million plots remain unregistered.

34. **There are significant issues surrounding tenure of forestland.** Since 1960, forests are considered domanial, meaning the property of the state. Forest estate comprises: (i) the domanial forest, including all forest grown on domanial land, and (ii) the national forest domain encompassing all demarcated forests that are classified under a ministerial order for a specific purpose.[29] The land reform of 2005, and specifically the Law 2005–019, introduced a new land regime called "areas under specific land statutes," which moved the forest from being considered domanial to a third regime of specific statutes to be regulated under a new law. Yet, the legislation regulating specific statutes has yet to be fully detailed. While the law on non–titled private property presumes that long-lasting occupation and development of domanial land can result in property rights, it is unclear how far such occupation rights would be recognized on domanial forest.[30] Community rights on forestland also remain to be re-addressed. Until now, communities have been granted the rights of use and occupation.[31] A bill on customary community land rights has been under development for four years but has not been promulgated for formal adoption.

35. **Land access and property rights incentives related to reforestation need to be effectively enforced.**Madagascar started to develop coherent

27 Ex-post assessments of the impacts of the reform on rural livelihoods were not included.

28 A legacy of this recent history, most forest lands and all of the official protected areas are on State owned land ("domaine de l'Etat").

29 The concept of NFD – National Forest Domain – qualifies forest cover subject to classification, delineation, and management by the ministry in charge of forestry. It encompasses strict Nature Reserves (RNI), Special Reserves (RS), National Parks (PN), Forest Stations (SF), Classified Forests (FC), Forest Reserves (RF), Perimeters of Reforestation and Restoration (PRR), and mangroves. The three first categories are labeled as Protected Areas.

30 However, the legal arrangement is clearly not allowing private acquisition of forestland under National Forest Domain, unless the parcel is declassified.

31 The concepts of Controlled Occupation Zone (ZOC) and Sustainable Use Zone (ZUD) are used to qualify the human settlements inside Protected Areas or in forestland under natural resources management transfer (GELOSE). The communities are only granted restricted land and resources rights of use.

strategies in the 1980s with the institution of the AFARB and ZODAFARB (Zone Délimitées pour l'Action en Faveur de l'Arbre)[32] areas designations to promote reforestation. Since 2000, Land Forest Reserve strategy (RFR) was introduced to promote restoration of degraded lands through individual- and community-driven reforestation, particularly within watersheds and sensitive zones on state-owned lands. The strategies include the promise of land title provided that the operator had effectively fulfilled the reforestation prerequisite. The ZODAFARB requires midterm evaluations in years three and eight, upon which the operator is to be awarded a land valuation certificate by the Ministry of Environment and Sustainable Development. The certificate would further support a land titling application at the operator's initiative. Collective titling on behalf of community reforestation is allowed through formal registration that requires the constitution of members into a legal association (as per the Ordinance 60–133). To date, several parcels remain reserved under ZODAFARB but few have been effectively titled to the operator, due to administrative procedures.

36. **Madagascar was one of the first countries in Africa to formalize community-based natural resource management.** In the 1990s Madagascar embarked on decentralization of natural resource management, with the aim of delivering environmental benefits while supporting local livelihoods. The management transfer is implemented through a contract among a grassroots community *(Vondron'Olona Ifotony* (VOI); *Communauté de Base* (COBA), the commune, and the deconcentrated forest authority. The VOI is responsible for the implementation of a sustainable management plan (also called Sustainable Planning and Management Scheme – see section on Governance) and has the power to manage the resources and receive the benefits directly but without being granted the ownership of the resources or the land. These benefits can include the sustainable harvesting of a broad range of resources that contribute to subsistence and household income: food (e.g., fruit, honey, bushmeat, wild tubers), firewood, building materials, cattle grazing and shelter, and traditional medicines. Commercial exploitation is potentially authorized but usually limited (e.g., commercial production of charcoal and wood planks).[33]

37. **Madagascar has also adopted laws to transfer the management of natural resources to the local populations.** In 1996 Madagascar adopted the law on Secure Local Management, or *Gestion Locale Sécurisée* (GELOSE), and in 2001 adapted this to forest management through the law on Contractualized Forest Management, or *Gestion Contractualisée des Forêts* (GCF). The GELOSE and GCF allow the transfer of natural resource management from the public domain to local populations. Communities are granted exclusive management rights over the space on which they claim traditional rights. Between 1996 and 2014, almost 1,250 contracts transferred the management of forests (95 percent of contracts), mangroves (3 percent) and fisheries (2 percent) to the surrounding populations. These contracts cover 5 percent of the Malagasy territory and 30 percent of the current forests, including 20 percent within protected areas (around core conservation areas). The use of community-based natural resource management is heavily donor driven in Madagascar: 93 percent of contracts were facilitated by an external actor.[34]

38. **Thirty years of expansion of community-based natural resource management have not slowed deforestation or biodiversity loss as much as anticipated.**[35,36,37,38] The country has lost close

32 Zone d'action en faveur de l'arbre (demarcated area for action in support of trees). Decree 3145 – 87.

33 Pollini, J., Hockley, N., Muttenzer, F.D., Ramamonjisoa, B.S., 2014. "The transfer of natural resource management rights to local communities." In: Scales, I.R. (Ed.), Conservation and Environmental Management in Madagascar. Routledge, London.

34 Vogel, A., Fétiveau, J., Groeber, S., Desbureaux, S., 2017. "Gouvernance partagée des aires protégées à Madagascar. Quel contenu donner à la cogestion ?" Comprendre, Agir et Partager, n°1. Editions du GRET.

35 Desbureaux, S., Aubert, S., Brimont, L., Karsenty, A., Lohanivo, A.C., Rakotondrabe, M., Razafindraibe, A.H., Razafiarijaona, J., 2016. "The Impact of Protected Areas on Deforestation: An Exploration of the Economic and Political Channels for Madagascar's Rainforests (2001–12)." Etudes et Documents, n°3, CERDI.

36 Desbureaux, S., Damania, R., 2018. "Rain, forests and farmers: Evidence of drought induced deforestation in Madagascar and its consequences for biodiversity conservation." Biological Conservation, 221:357-364.

37 Eklund, J., Coad, L., Geldmann, J., and Cabeza, M., 2019. "What Constitutes a Useful Measure of Protected Area Effectiveness? A Case Study of Management Inputs and Protected Area Impacts in Madagascar." Conservation Science and Practice, 1 (10).

38 These assessments have mostly focused on the historical protected areas, those managed by MNP for which long-term data exists. There is a consensus among stakeholders (including promoters of new protected areas) that new protected areas do not perform better. One of the promises of management transfers is that communities will improve their livelihoods by directly receiving the benefits of well-managed natural resources on which they rely (e.g., food, firewood, building materials, and traditional medicines). Estimate the impact of community forest management impacts on household living standards, as measured by per capita consumption expenditures. The estimated impact is positive, but small and not statistically different from zero.

to 20 percent of its forest cover since 1990. Although the shift to shared governance and co-management should in principle result in more effective improvement of human well-being, this has not yet substantially materialized systematically, reducing incentives to halt degradation. VOIs (village organizations) have had limited capacity to implement GCF (management contracts) and *dina* rules[39,40] further limit their authority. There have also been issues with migrants moving in from other areas, distrust between stakeholders, and concerns with the effectiveness of power transfer.[41]

Governance Challenges

39. Landscapes, by definition, span multiple jurisdictions and require strong governance arrangements for effective management. While landscape approaches often operate within geographical boundaries, recognizing, for example, that upstream degradation can impact the productivity and sustainability of activities downstream, the effectiveness of landscape approaches is also dependent on effective governance, especially at the decentralized level. Often, administrative boundaries do not neatly follow geographical boundaries, complicating decision making regarding integrated landscape approaches. Nested planning is needed to identify priority areas for intervention at the landscape level with more detailed plans at the micro-catchment level with details of specific interventions.

40. Following independence, Madagascar opted for the adoption of a decentralization model of governance, and created territorial structures (Provinces, Prefectures later named Districts, and Communes) as well as democratic popular assemblies – *fokonolona* – at the village level. Nonetheless, the central government retained the prerogative for sector and public policy design, as well as budget decisions. Territorial structures were effectively only assigned responsibility for execution. Political willingness to assign more responsibility to Communes emerged in the 1990s with the adoption of the pioneer laws 94–007 and 94–008. The laws introduced a system of "proximity governance" with the creation of 22 Regions, replacing the six Provinces, and the ability for regional planning was transferred to this level.[42] Delegation of responsibilities from central ministries to Communes was triggered by Law 96–025 which promoted the transfer of natural resources management to local level communities (as noted above; See Box 2.1 for more information on the status of decentralization). Current decentralized territorial administration comprises two main effective levels: 23 regions and approximately 1,700 communes, in addition to 18,250 localities (fokontany).[43]

41. The country has developed several institutional arrangements to make its decentralization policy more effective, which are relevant to integrated landscape management.[44] These include:

- Several land-use planning instruments that promote the use of landscape approach in relevant ministerial departments and in local authorities: National Land Use Planning Scheme *(Schéma National d'Aménagement du Territoire),* Regional Land Use Planning Scheme *(Schéma Régional d'Aménagement du Territoire),* and Communal Land Use Planning Scheme *(Schéma d'Aménagement Communal,* SAC), with separate approaches for urban and rural area: for rural, the Intercommunal Land Use Planning Scheme *(Schéma d'Aménagement InterCommunal,* SAIC),

39 Vogel et al., 2017. Available at: https://www.researchgate.net/publication/297962919_Using_the_dina_tool_as_governance_of_natural_resources_lessons_of_Velondriake_southwestern_Madagascar

40 In order to reduce conflict between national laws and local customs and social norms (known as dina), the government of Madagascar has progressively decentralized the governance of natural resources to local levels. The 'dina', which can be translated as social pact, is a customary institution defined as a traditional local convention used to establish common rules for the purpose of social cohesion, mutual aid or security, and which includes sanctions for non-compliance. Rules regarding resource use within contractual management transfers and co-managed protected areas are defined within dina, which can be legally recognized.

41 Jones, J.P.G., Rakotonarivo, O.S., Razafimanahaka, J.H, 2021. Forest Conservation in Madagascar: Past, Present, and Future. In S. M. Goodman (Ed.), The New Natural History of Madagascar. Princeton University Press.

42 The regions are also subdivided into 119 districts, headed by a chief, who is the representative of the State at the district level. He oversees the implementation of the general policy of the State within his territorial jurisdiction, has authority over the heads of the decentralized State services located in his territorial jurisdiction and is responsible for the control of legality of the acts of the decentralized territorial authorities, particularly the communes.

43 The fokontany are basic administrative subdivisions of the state at the commune level. The fokontany chief is appointed by order of the district chief to ensure (i) the development of his locality; (ii) the maintenance of security; (iii) the mobilization of communities for health, education and culture; and (iv) supporting the State in carrying out activities that directly affect the population.

44 Harilanto Ravelomanantsoa and Rajaonario Andrianarivelo, 2021. Politique ouverte : structures locales de concertation dans les municipalités de Sahanivotry et Masindray, Madagascar. UNESCO.

Box 2.1. Status of Decentralization in the Government of Madagascar

Government was traditionally highly centralized but has been undergoing a decentralization process over the last two decades. The objective is to increase the capacity for decision making at sub-national levels, improving the responsiveness of policy implementation to local concerns, and involving citizens, through their elected representatives, in the management of local affairs.

Decentralization is taking place at two levels:

(i) Through Decentralized territorial collectivities *(Collectivités Territoriales Décentralisées (CTD),* made up of communes (including municipalities with elected mayors), regions and provinces. CTDs receive (i) a share of the taxes and duties collected for the state budget, but also (ii) taxes and duties voted by their Board. CTDs at the communal level are responsible for delivering local infrastructure and environmental services such as water supply, and sanitation and solid waste management, as well as land-use planning.

(ii) Through *Deconcentrated Technical Services, or Services Techniques Déconcentrés (STD)*, branches of sectoral ministries at the regional and sub-regional level which constitute the 'technical de-concentration' of the State and whose purpose is to the strengthen the 'action capacities' of the CTDs. Deconcentrated services also oversee national policy and undertake state administrative functions at sub-national levels.

and for urban, the Urban Masterplan *(Plan d'Urbanisme Directeur)* and Detailed Urban Plan (Plan d'Urbanisme Détaillé). In addition, the Local Land Occupancy Plan *(Plan Local d'Occupation Foncière)* is a particular satellite imagery-based map used by Communes equipped with Communal Land Offices.

- At the community level, Simplified Planning and Management Schemes (PAGS) have been prepared for at least three decades to promote community–based natural resources management and inclusive conservation strategies for protected areas. These are five-year plans that aim to balance community livelihood activities and sustainable use of natural resources.
- Local consultation structures *(Structures Locales de Concertation)* at the level of Communes aim to promote effective participation of stakeholders and citizens in the management of public affairs and development actions.
- The Local Development Fund *(Fonds de Développement Local)* and the National Institute for Decentralization and Local Development *(Institut National de la Décentralisation et du Développement local)* are responsible for strengthening the capacity of local actors, the practical exercise of local democracy and accountability, and the financing of investments at the local level to improve the provision of public services.
- Participatory budgets: About 100 communes have been implementing the participatory budget process for the implementation of activities in the SAC.

42. **There isn't a lot of information on the implementation of these institutional arrangements.** These management instruments have been created relatively recently, are not applied systematically and are most often associated with donor-funded projects. For instance, only 200 communes have a functional local consultation structure, according to the government.[45] SACs are predominantly prepared by projects funded by bilateral and multilateral donors. There is so far no public or broad assessment of the implementation of these different tools, including the land-use planning instruments, and their effectiveness.

45 Studio Sifaka, 2021. Structure locale de concertation : quand participation et redevabilite vont de pair. Available at: https://www.studiosifaka.org/articles/actualites/item/4114-structure-locale-de-concertation-quand-participation-et-redevabilite-vont-de-pair.html

43. **Despite these efforts, Madagascar remains a highly centralized country.** 86 percent of the state budget is implemented at the central level and 14 percent at regional levels. Less than 1 percent of the overall government budget is allocated to communes nationwide (US$7,500 per commune on average), leaving communes without budgets or capacity to cover the expenses for development, and hampering planning and service delivery. Effective decentralization faces several barriers: lack of understanding and ownership of the decentralization and local development agenda by the population; unstable institutional anchoring and weak leadership in steering the implementation; failure to comply with the laws and regulation, and the absence of implementing decrees (a problem in many areas of government) that are needed to implement legislation; and insufficient consideration of decentralization in sectoral policies. The recent imposition of a state of emergency due to the COVID-19 crisis has added to the centralization of power within the executive branch.[46,47] Advisory support to CTDs by the various STDs is fragmented between sectoral ministries, and inclusive citizen participation remains limited. The current government, as part of its commitment to improve the autonomy and accountability of CTDs, has launched a process[48] for improving the effectiveness of decentralization, and is currently finalizing a National Emerging Decentralization Plan, *or Plan National de Décentralisation Emergente*[49] (PNDE). One aim is the 'territorialization of public policies' by improving coordination between the sectoral ministries and their technical services at the territorial level to improve the human, financial, technical and material resources available to CTDs for carrying out their local development missions.

44. **The current governance arrangements in Madagascar present challenges for improved integrated landscape management.** Most land use planning decisions for agriculture, water and forests are taken by three sector ministries: the Ministry of Agriculture and Livestock (MAL); the Ministry of Water, Sanitation and Hygiene (MWSH); and the Ministry of Environment and Sustainable Development (MEDD). Each of these Ministries has "deconcentrated" staff in regions and districts to advise regional and communal governments. Communes are responsible for the preparation of the SAC and SAIC, and coordination of the SAC is assigned to the regional level. Other key ministries include the Ministry of Territorial Planning and Land Management (MTPLM) and the Ministry of Interior and Decentralization (MID), to which the regional chiefs and communal mayors report. The coordination among sectoral ministries and among levels of government is insufficient. Large development projects are decided at the level of the sectoral ministries, while smaller initiatives (e.g., communal reforestation) are led by communes, and these efforts are not necessarily coordinated. Not many staff from MAL, MWSH, and MEDD reported being aware of the National Land Use Planning Scheme developed by the MTPLM. The government, both at the central and local levels, also lacks technical capacity to carry out all the different steps required for land-use planning (e.g., collecting data and putting in place the dynamic geospatial database, ensuring data quality, conducting analyses and developing spatial models for scenario analysis, as well as broad consultations).[50]

IMPLEMENTING ILM: ADDRESSING THE KEY DRIVER OF DEFORESTATION AND DEGRADATION[51]

45. **Madagascar's population is highly dependent on biomass for cooking.**[52,53] Traditional biomass (firewood and charcoal) accounts for more than 99.3 percent of total primary energy use

46 Ravelomanantsoa H., R. Andrianarivelo, 2021. Politique ouverte : structures locales de concertation dans les municipalités de Sahanivotry et Masindray, Madagascar. UNESCO.

47 World Bank, 2022. 2022 Systematic Country Diagnostic Update for Madagascar. Reducing Poverty by Strengthening Governance and Accelerating Structural Transformation. Washington, DC: World Bank.

48 As such, national / regional / local consultations have been held with all the stakeholders in order to determine the major axes of a new Emerging Decentralization Policy Letter (LPDE, Lettre de Politique de Décentralisation Emergente, Law No. 2021-011 of June 23, 2021 validating the Emerging Decentralization Policy Letter).

49 Midimadagasikara, 2021. Decentralisation emergente : Un plan national en gestation. Available at: https://www.midi-madagasikara.mg/2021/07/06/decentralisation-emergente-un-plan-national-en-gestation/

50 World Bank, 2017. Madagascar—Sustainable Landscape Management Project. Project Appraisal Document. Washington, DC: World Bank.

51 This section is based on a recent analysis: Madagascar Cooking Sector – Initial Assessment Support to Madagascar Country Environmental Analysis (CEA), prepared by the Energy Sector Management Assistance Program (ESMAP) for this report.

52 World Bank, 2021. Beyond Connections: Madagascar Energy Access Diagnostic Report Based on Multi-Tier Framework. According to the World Bank's Multi-Tier Framework (MTF) household survey data in Madagascar (2021). World Bank Group.

53 Energydata.info. Madagascar Country Profile. Available at: https://energydata.info/.

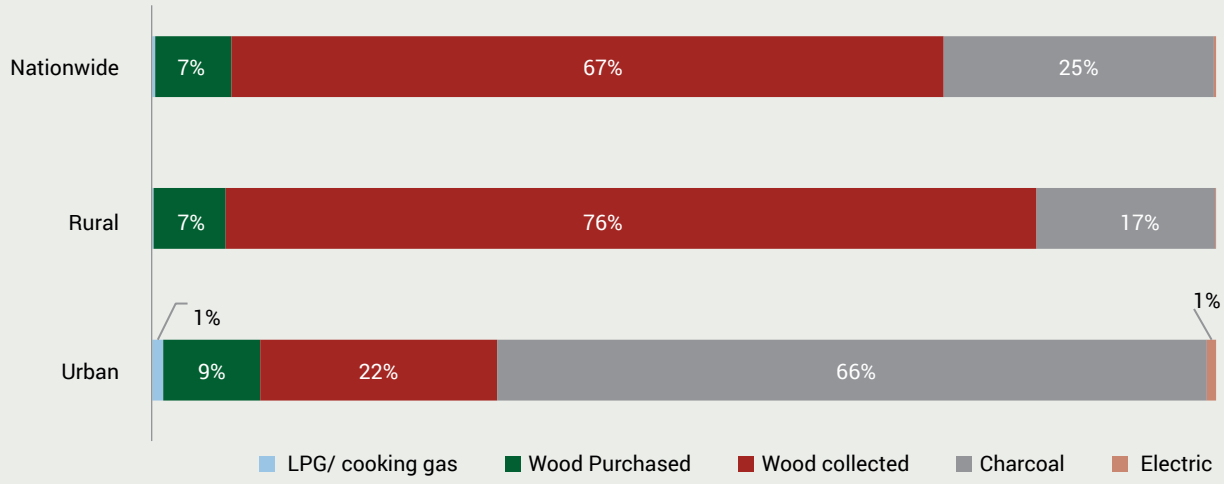
in Malagasy households. Nationally, the most common fuel used for cooking is firewood (74 percent) followed by charcoal (25 percent). 83 percent of households in rural areas and 31 percent in urban areas use firewood as the primary fuel for cooking, while for 66 percent of households in urban areas and 17 percent in rural areas, charcoal is the primary source. Three-stone stoves are the primary cooking solutions for rural households (71.6 percent). The use of Improved Cookstoves (ICS) is prevalent in urban households (67.2 percent), compared with only 24.3 percent in rural areas (driven by lack of affordability and ready access to wood fuel and the materials for basic stoves). The use of clean fuel stoves (LPG and electric) remains very low in Madagascar, with less than 1 percent of households nationwide reporting using one of these stoves. Use of ethanol has been supported but is still only used by a small number of households.

46. **The high dependence on traditional biomass places a heavy health burden.** Unlike Madagascar's peer countries, the number of deaths attributable to Household Air Pollution (HAP) did not decrease in the last two decades (see figure 2.9). Deaths due to indoor PM2.5 pollution were at 21,600 in 2000 and remained at 21,500 in 2019. Madagascar's peer group countries such as Uganda, Cambodia, and Rwanda observed a significant decrease in the number of deaths from HAP during the same timeframe. Uganda achieved an 18 percent decrease in deaths from 28,100 in 2000 to 23,000 in 2019. Cambodia achieved a 22 percent drop from 18,000 to 14,000, and Rwanda a 30 percent decrease from 10,600 to 7,470.

47. **Use of fuelwood for cooking has productivity and environmental costs, particularly for women and children.** The gender cost is estimated at US$4.71 billion annually, due to lost productivity from extended time spent on cooking-related tasks, including fuel collection, cooking, and stove cleaning. In Madagascar, it is estimated that women in rural areas spend around 14 hours per week on cooking-related tasks, and women in urban areas spend nine hours per week. Finally, the climate-impact cost is estimated at US$1.44 billion per year (using a social cost of carbon of US$45.9 per ton), based on estimates of 22.09 million tons of CO2 emissions per year in rural areas, and 9.26 million tons of CO2 emissions in urban areas.

48. **Heavy dependence on biomass for cooking contributes to forest degradation and deforestation.** Estimates from 2005[54] indicate that while woody biomass removals for fuelwood totaled 12.8 million m^3 annually, those for industrial round wood were 0.238 m^3 annually. A more recent study estimates national consumption of about 18

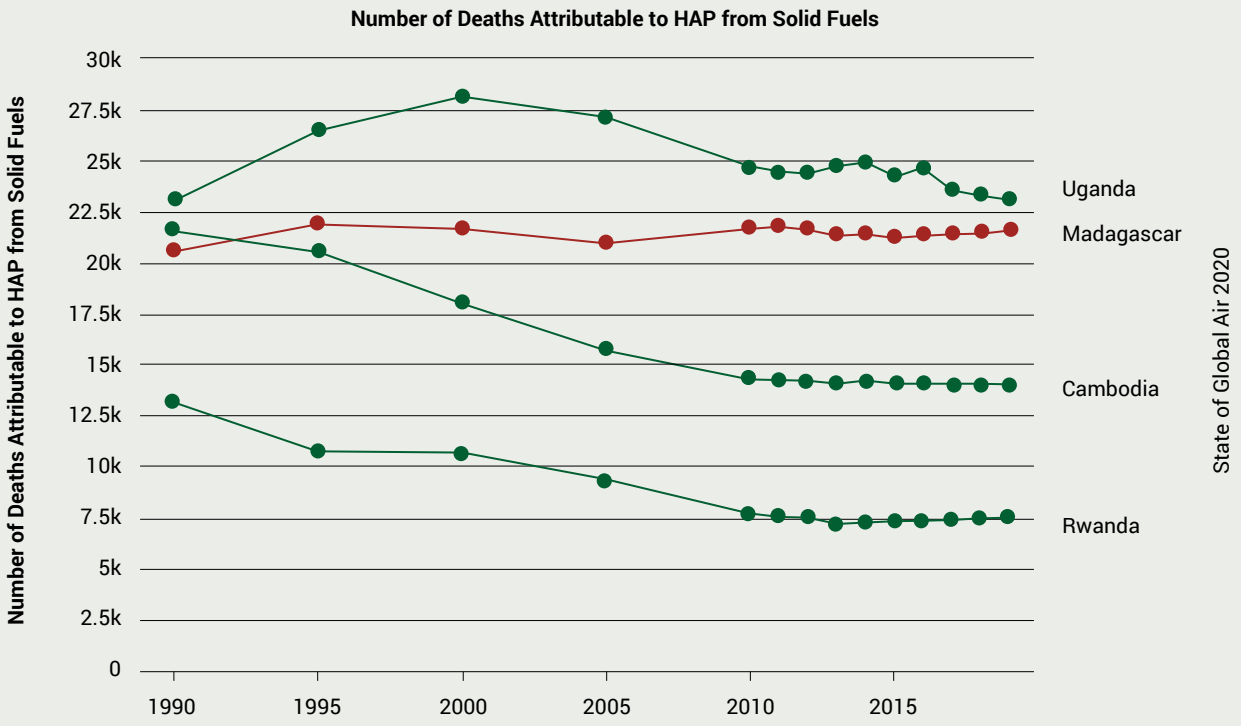
Figure 2.8. Primary Cooking Fuels in Madagascar (nationwide, urban, rural)



Source: World Bank Madagascar Multi-Tier Framework (MTF) report, August 2021.

54 Karin Buncht, 2015. Plantation Projects in Madagascar: Approaches, Objectives and Reflections for Fuelwood Production. Yale School of the Environment. Available at: https://tri.yale.edu/publications/tropical-resources-bulletin/tri-bulletin-archive/tropical-resources-vol-34/plantation

Figure 2.9. Number of Deaths Attributable to Household Air Pollution from Solid Fuels from 1990 to 2019 in Madagascar, Cambodia, Rwanda, and Uganda



Source: Health Effects Institute. 2020. State of Global Air 2020. **Data source:** Global Burden of Disease Study 2019. IHME, 2020.

million cubic meters total for firewood (9 million m^3) and wood as charcoal for cooking (8.6 million m^3).[55] Most of these removals are from natural forest and wooded areas, though Madagascar has an estimated 312,000 ha of fuelwood plantations (primarily eucalyptus) that are used primarily as a source of charcoal for urban areas.

49. **The Government's clean cooking policy is guided by the country's overarching energy policy, *'La Nouvelle Politique de l'Energie 2015-2030'*.**[56] Cooking-related targets for 2030 include: (i) 70 percent access to energy-efficient cookstoves, (ii) 50 percent of wood to be sourced from legal and sustainable forest resources, and (iii) 20 percent of charcoal to be 'green,' having been produced efficiently and from legal and sustainable forest resources. Several plans to scale up access to clean cooking solutions have been prepared, such as regional strategies for energy including wood energy, and a national program to promote ethanol. Expansion of clean cooking solutions is included in the government's commitments under its NDC[57] as well as in the 2019-23 Initiative for an Emergent Madagascar.[58]

50. **Progress on adoption of cleaner cooking solutions has been and is expected to continue to be slow, and fuelwood and charcoal will remain dominant fuels in the coming decades.** A 2019 study on Energy Finance in Madagascar[59] predicted that the use of clean fuels – LPG, biogas, and ethanol (see

55 World Bank, 2011. Ethanol as a household fuel in Madagascar: health benefits, economic assessment, and review of African lessons for scaling-up: summary report. Washington, DC: World Bank Group. Available at: https://documents.worldbank.org/en/publication/documents-reports/documentdetail/564801468055752320/ethanol-as-a-household-fuel-in-madagascar-health-benefits-economic-assessment-and-review-of-african-lessons-for-scaling-up-summary-report

56 Republic of Madagascar, 2015. Lettre de Politique de l'Energie de Madagascar 2015 – 2030. Available at: https://rise.esmap.org/data/files/library/madagascar/Documents/Renewable%20Energy/Madagascar_Lettre%20de%20la%20Politique%20de%20l'energie_2015-30.pdf

57 Republic of Madagascar, 2016. Madagascar's Intended Nationally Determined Contribution. Available at: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Madagascar%20First/Madagascar%20INDC%20Eng.pdf

58 Initiative Emergence Madagascar. Available at: http://iem-madagascar.com/

59 SEforALL, 2019. Taking the Pulse of Energy Access in Madagascar. Energizing Finance Report Series. Available at: https://www.seforall.org/system/files/2019-12/Taking-Pulse-Madagascar_0.pdf

box 2.2 on ethanol program) – would increase to only half a million households by 2030, with further growth constrained by affordability and logistical challenges (including very poor road infrastructure constraining distribution of ethanol/LPG containers/refills). There have been difficulties in producing ethanol locally, and international prices are high due to both the recent COVID-19 outbreak (ethanol is used in hand sanitizers) and global energy price inflation. Use of LPG is very limited[60,61] compared with other East African countries, in part because LPG must be imported. Biogas has benefited from Norwegian NGO and Chinese support in the 2009 to 2015 period.[62] The most recent figures available indicate that 492 household biodigesters had been built by 2015.[63] There appears to have been little progress since, although biogas is included as a priority in the Ministry's guidance for activities to be undertaken in 2019. The Energy Finance study estimates that nine million households will continue to use fuelwood or charcoal through 2030. The challenge will be to produce and harvest these resources more sustainably, and to provide incentives for most households to use improved cook-stoves while gradually supporting increased uptake of modern clean cooking solutions.

51. **There have also been some initiatives with public-private partnerships in planted forests.** Investors have signed 30-year leases with the forest administration. Wood products have been used in part for manufacture of briquettes, including for textile companies in Antananarivo and Fianarantsoa. The European Union is assisting with a program to rehabilitate and expand fuelwood plantations in the area around Antananarivo.[66] There are further opportunities to provide wood products from plantations to clusters of users, such as textile producers in Antsirabe, that currently use a lot of energy with only limited sources of managed fuelwood. A recent study summarizes the experience with fuelwood plantations and draws some interesting lessons (see box 2.3).

52. **Madagascar's government is committed to providing access to improved and cleaner cooking solutions, but a comprehensive approach is needed.** In particular, support for improved energy solutions needs to be combined with programs to increase fuelwood production and harvesting from sustainably managed natural woodlands and plantations, and incentives need to be in

Box 2.2. Increasing Uptake of Ethanol

The government has included prioritizing ethanol in the current five-year development strategy, and a recent decision to remove excise duty for ethanol fuel sent a positive signal to the market.[64] The Ministry of Industry (MoI) is technically responsible for approving Ethanol Micro Distilleries (EMDs) and promoting ethanol clean cooking. There has been support to increase use of ethanol-based stoves through a World Bank supported program of US$10.7 million for an emissions reduction purchase agreement[65] with Green Development AS, a private company focused on carbon financing, as part of the Carbon Initiative for Development (Ci-Dev). The agreement involves the purchase of 1.1 million certified emission reductions (CERs) to be generated by the end of 2024 through a range of activities, including ethanol cooking. Progress has been slower than expected for a number of reasons, but the project had distributed and registered 12,698 stoves as of December 3rd, 2021 – representing 36 percent of the end project objective – and reached 30 percent of the emissions reduction target.

60 SEforALL, 2019. Energizing Finance: Taking the Pulse 2019. Energizing Finance Report Series. Available at: https://www.seforall.org/system/files/2019-11/EF-2019-TP-SEforALL-w.pdf

61 Current storage capacity is sufficient for 100,000-125,000 households.

62 Oméga Razanakoto, Lars Kåre Grimsby, Guo Jing, Elisabeth Rabakonandrianina, 2015. Final Evaluation of the International NMS Biogas Partnership Program.

63 Multi-tier Access Report 2012.

64 Erik Reed, 2021. Disclosable Restructuring Paper - MG ethanol clean cooking climate finance program - P154440 (English). Washington, DC: World Bank Group. Available at: http://documents.worldbank.org/curated/en/796161623356999444/Disclosable-Restructuring-Paper-MG-ethanol-clean-cooking-climate-finance-program-P154440

65 World Bank. MG Ethanol Clean Cooking Climate Finance Program. Available at: https://projects.worldbank.org/en/projects-operations/project-detail/P154440, https://documents1.worldbank.org/curated/en/395881468266106457/text/PID-Appraisal-Print-P154440-04-21-2016-1461259255237.txt

66 USAID, 2021. Stimulating Smallholder Tree Cultivation for Woodfuel: Learning from Success in Madagascar. Available at: https://www.climatelinks.org/sites/default/files/asset/document/2021-02/ProLand%20Madagascar%20Woodfuel%20Case%20Study%20Final.pdf

Box 2.3. Stimulating Smallholder Cultivation for Woodfuel: Learning from Success in Madagascar

A recent study provides helpful lessons for wood-fuel cultivation in Madagascar. It notes that experience and approaches are differentiated by region.

Antananarivo is a special case. For this large market, privately owned plantations (primarily eucalyptus) account for 74 percent of the charcoal market, pinewood plantations 22 percent and natural forests only 4 percent. Plantation owners have mostly inherited the plantations from families to whom they were transferred in the post-colonial period. It has been relatively easy to regulate wood-fuel and charcoal supply to the capital, which has deterred smaller, less well-connected producers.

Other regions require different approaches. In the southern uplands (Antsirabe, Ambositra, and Fianarantsoa) there have been more constraints to sustainable fuelwood production and easier access to natural forests. Industrial enterprises (e.g., the Cotona fabric mill in Antsirabe and essential oil distilleries) are also large consumers. It is also more difficult for local farmers to obtain land tenure permits, and the local forest authorities are less resourced to prevent incursions into natural forest areas. But local farmers are integrating trees into production systems, and an ongoing local program is conditioning charcoal permits on replanting trees and provision of seeds. In the drier west the situation is more challenging, and the charcoal market drives deforestation, including of coastal mangroves. A series of programs have improved conditions for smallholder fuelwood production. A current GIZ supported program, the Program d'Appui à la Gestion de l'Environnement, Composante Bois-Energie, has trained individual farmers in transplanting seedlings and techniques to maximize tree health and the production of wood, and worked with local authorities to establish local land offices where farmers can obtain land tenure certificates. GIZ is also supporting the establishment and operation of green energy cooperatives, which allow producers to reduce transportation fees by aggregating their produce and, in operating within the law, avoid the heavy bribes inherent to illicit trade.

The study has five principle recommendations for expanding sustainable fuelwood and tree plantations in Madagascar:

- Overcome technical skills constraints, including tree propagation, transplanting, and maintenance and harvesting, and address the limited supply of seed stock.
- Diversify the limited genetic supply of seed stock and overcome broader supply constraints.
- Reduce competition from illicit trade through supporting governmental efforts to monitor supply chain and production trends, and exploring legislative and administrative alternatives to the current production and transport permitting system.
- Improve land tenure security by supporting and expanding the local land certificate offices and support public education to reduce fire, theft and vandalism.
- Improve market incentives through support for producer cooperatives to reduce transformation, transport and marketing costs, and support the certification of producers using planted wood produced from legal sources.

Source: USAID, 2021. Stimulating Smallholder Tree Cultivation for Woodfuel: Learning from Success in Madagascar. Available at: https://www.climatelinks.org/sites/default/files/asset/document/2021-02/ProLand%20Madagascar%20Woodfuel%20Case%20Study%20Final.pdf

place to support this. These two areas tend to be addressed separately, through the energy or the forestry lenses, in policies and programs, but they need to be addressed together. More specifically, it is recommended that the government:

(i) Prioritize access to clean cooking in national policies by building institutional capacity and assigning a lead agency to coordinate with other related agencies, = formalize cooking energy demand in national energy planning and develop of a strategy for achieving universal access to clean cooking,

(ii) Work cross-sectorally to ensure that woodfuel is produced sustainably, by supporting woodfuel plantations and community woodlots,

(iii) Continue to support expanded use of improved fuelwood and charcoal burning cookstoves, with financial incentives if necessary; consider the use of carbon finance instruments to support these; Continue to support gradual expansion of clean cooking alternatives (ethanol, in particular), solar powered cookers, and biogas energy.

(iv) Scale up public and private financing by working with development partners and developing incentive mechanisms to attract private investments.

IMPLEMENTING ILM: LEARNING FROM RECENT PROJECT EXPERIENCES

53. **Madagascar's experience in integrated landscape management is relatively recent, with a number of efforts still narrowly focused on forest management despite their reference to landscape approaches.**[67] In 2017 the country developed a National Strategy for the Restoration of Forested Landscapes under the international AFR100 initiative.[68] The aim of the program is to transform four million hectares of deforested and degraded lands into resilient and multifunctional ecosystems by 2030. Forest restoration remains a sectoral endeavor spearheaded by the Ministry of Environment and Sustainable Development, without a cross-sectoral planning effort. The Reduced Emissions from Deforestation and Degradation (REDD+) Atiala Atsinanana project[69] similarly highlights the multiple benefits of forests and aims "to reduce deforestation and forest degradation through a landscape approach…". Nevertheless, the focus and funding of the project is on reduction of forest degradation and deforestation to sequester carbon and secure related payments[70] from the Forest Carbon Partnership Facility Carbon Fund.

54. **The Sustainable Landscape Management *Project (Projet d'Appui à une Agriculture Durable par une Approche Paysage,* PADAP) was designed as a prototype for integrated landscape management in Madagascar.** The PADAP integrates all the elements that should be part of a typical landscape project. *It is multi-functional,* aimed at improving food production, biodiversity or ecosystem conservation, and rural livelihoods. *It works at a landscape-level and coordinates across sectors* and actors. *It is participatory,* supporting adaptive, collaborative management within a social learning framework. Coordination across sectors is led by an Inter-Ministerial Project Steering Committee and three regional committees. In each landscape, co-management is assured by multi-stakeholder platforms comprising (in principle) of mayors, fokontany chiefs, traditional chiefs, sectoral representatives, biodiversity conservation representatives, district-level technicians from deconcentrated technical services, development organizations, churches, civil society, and migrant spokespersons. Members of these platforms are responsible for preparing[71] participatory diagnostics, participatory zoning *(Zonage à Dire d'Acteurs)*,[72] and activity proposals. In addition, Sustainable Land Management Plans (SLMP) use the local administration levels (communes and some representative fokontany) – major actors in local development – to consult landscape inhabitants and participate in the preparation and implementation of SLMPs.

67 There is rich experience to draw on from other countries, including through the Terrafrique program, which in many countries has been adapted, expanded and evolved over the last 20 years. Ethiopia, Kenya, Zambia, Malawi and the Sahel, among others; the specific focus of each varies.

68 Afr100. Madagascar Country Profile. Available at: https://afr100.org/content/madagascar

69 World Bank, 2021. Madagascar – Atiala-Atsinanana Emission Reduction Program Project. Washington, DC: World Bank Group. Available at: https://documents1.worldbank.org/curated/en/350501617311764540/pdf/Madagascar-Atiala-Atsinanana-Emission-Reductions-Program-Project.pdf

70 World Bank, 2022. Advanced Draft Benefit Sharing Plan: ER Program Atiala-Atsinanana (English). Washington, D.C.: World Bank Group. Available at: http://documents.worldbank.org/curated/en/142031644397335762/Advanced-Draft-Benefit-Sharing-Plan-ER-Program-Atiala-Atsinanana

71 Guide pour l'élaboration du PAGDP, 2020.

72 Zonage à Dire d'Acteurs are a participatory spatialization tool for activities and projects. They are used to integrate physical, historical, and spatial data on a map and, by facilitating stakeholder dialogue, allow users to understand landscape dynamics, identify issues, and propose future scenarios.

55. **The Support for Resilient Livelihoods in the South of Madagascar Project (Mionjo)[73] project design comprises some important aspects of integrated landscape management.** *It is multi-functional,* supporting activities in climate smart agriculture and irrigation, and local service delivery including water supply and forestry (though focused on drought management and resilience rather than broader ecosystem and biodiversity conservation). It includes landscape management elements, such as support for reforestation to protect the upstream of springs feeding the Efaho and Mandrare rivers and securing breeding grounds for fisheries. It involves some inter-sectoral coordination at the levels of the inter-ministerial steering committee and the local consultation structures, but less with the deconcentrated agencies. *It is participatory*, working with established decentralized structures and local groups at the commune level to identify investment priorities through the preparation of the Local Development Plans.[74]

56. **PADAP is the first step on the path toward integrated landscape management in Madagascar.** Despite implementation difficulties, integrated landscape management remains a promising tool to support sustainable rural development and increase climate resilience. In part due to the PADAP project, there is now a shift in the conceptualization of rural development in Madagascar with the government and its technical and financial partners referring increasingly to the need for integrated landscape management.

57. **Challenges in the implementation of PADAP, however, highlight the need to invent a more pragmatic integrated landscape management approach in the country.** An early evaluation of the PADAP project reveals some lessons that could be used to amend the design of future landscape projects – in line with the increasing adoption of integrated landscape management in Madagascar – and make them more successful and sustainable:

    (i) Simplify the landscape approach. Many elements of the gold standard of integrated landscape management should be sacrificed on the altar of pragmatism. The SLMP process could be more straightforward by adopting less ambitious but more visible integration strategies, and using more streamlined data collection but less intensive stakeholder participation. Data collectors could make better use of local knowledge and available data, and only generate new data when critical. Landscapes should be less numerous and smaller to promote visibility in landscape interactions and avoid diluting the effort. Hotspots of land degradation could be prioritized, with a view to addressing the root causes of degradation. The context in Madagascar (e.g., weak governance and low levels of investments in human and physical capital) could be usefully regarded as fixed constraints with which to design the landscape approach, rather than aiming to solve them to implement a more ambitious landscape approach. Simple initial designs (including SLMPs) could be expanded over time using continual improvement processes.

    (ii) Increase the use of existing planning instruments. This is an advantage of the Mionjo project. The landscape approach could make greater use of existing rural planning tools in Madagascar to improve sustainability, increase regulatory power, and avoid redundancy and frustration from local stakeholders. *Schémas d'Aménagement Communaux* are obvious candidates, as are *Schémas d'Aménagement Intercommunaux and Schémas Régionaux d'Aménagement du Territoire.* The PADAP is financing the transcription of some SLMPs into *Schémas d'Aménagement Communaux,* but it could be systematic, and SLMPs could even be designed as *Schémas d'Aménagement Communaux* to simplify the implementation of the landscape approach.

    (iii) Enhance the synergy between planning and investments. The drafting of SLMPs during project preparation instead of project implementation would leave more time for investments to be implemented on the ground during the life of the project. This would increase the impact of the project and

73 World Bank, 2022. Support for Resilient Livelihoods in the South of Madagascar. Available at: https://projects.worldbank.org/en/projects-operations/project-detail/P171056

74 In addition, the Sustainable Landscapes in Eastern Madagascar project was approved in 2016, to be implemented by Conservation International and co-financed by EIB and the Green Climate Fund through a landscape approach. Implementation has been slower than anticipated, in part because of the COVID-19 pandemic, and in 2021 EIB withdrew its funding.

improve disbursement ratios. The no-regret investments planned in the PADAP project were an effective strategy to boost local adherence to the landscape approach. They confirmed the importance of programming early investments parallel to the planning exercise. The programming of these early investments could be based on the prior identification of land degradation hotspots, with a view to focusing investments in these areas from the start and increasing the impact of the project.

(iv) *Invest in capacity building and knowledge.* The PADAP project revealed the difficulty for the local population, technical experts, and the administration in moving away from a sectoral vision of rural development towards a more integrated, ecosystem-based approach. It could prove useful in the long term to invest in capacity-building on the different aspects of integrated landscape management. In collaboration with projects, universities are the most relevant partners to transfer cutting-edge knowledge on landscape and integrated approach.

(v) *Commit to the long term.* Like most natural resources management processes that require innovation, stakeholder participation, and integration and do not yield immediate results, integrated landscape management involves time scales that exceed typical project lengths to have impact. Stakeholders – including donors – must commit to long term, iterative, bottom-up, negotiated processes. Investing in integrated landscape management should be seen as long-lasting commitments, for example, through a series of projects, supplying ongoing support in the form of funding, technical backstopping, and/or other human resources. Within this long timeframe, SLMPs should be revised regularly, as are most sustainable natural resources management plans. There are two potential strategies:

- Mainstreaming the landscape approach into other rural development projects to instill principles of integrated landscape management with a view to improving their sustainability. This approach sees the landscape approach more as a means toward an end rather than an objective per se. The Mionjo and the Rural livelihoods productivity and resilience projects could be interesting candidates, as well as biodiversity, forest management, and hydroelectric projects.
- Another stand-alone landscape investment project financing, similar to the PADAP approach and in line with the series of projects anticipated in PADAP's project appraisal document but improved using the lessons described above. Shifting from an input-based to a long-term performance-based approach in the financing of landscape projects could provide additional incentive to the sustainable management of landscapes. Large-scale, international payments for environmental services (including REDD+) could also provide longer-term financing than shorter investment projects.

(vi) *Collaborate to improve the landscape approach.* Most technical and financial partners in Madagascar are progressively implementing some form of integrated landscape management in rural development projects. They will be adopting different approaches, trying different combinations of cross-sectoral coordination, institutional setup and stakeholder participation, working in different contexts, and providing together a breadth of knowledge that will be useful to all. It would be essential that this knowledge is shared, and the progressive design of a suitable landscape approach is collaborative. Other donors have expressed their strong interest in setting up such a collaboration mechanism.

CONCLUSIONS AND SUMMARY OF RECOMMENDATIONS

58. **There is increasing agreement that adopting a landscape approach, which recognizes the impacts of activities across space and sectors, is key to sustainable and resilient development.** Elements for success include inter-sectoral collaboration, local participation and use of local knowledge, recognition of country contexts, the need for short term as well as long term benefits, and approaches which can be easily adopted where capacity is limited and there are data limitations. Successful landscape approaches will not only incorporate an understanding of spatial interactions (the impact, for example, of upstream land degradation on the sustainability of downstream agriculture and irrigation developments), but will also recognize the importance of using existing administrative structures and local institutions to maximize ownership.

Table 2.1. Summary of Recommendations

Policy Objective	Instruments				Implementing Agencies
	Assessment	Policy and Regulatory Reform	Capacity Building	Investment	
Promote tenure security for forest and non-forest lands		Detail the legislation regulating the specific statues for forest lands (including fuelwood plantations around cities). Adopt the bill on customary community land rights. Clarify administrative procedures to title ZODAFARB parcels.	Strengthen capacity of local land offices to process backlog of land certificates.		MEDD, MATSF potentially, in collaboration with CASEF
Improve regulatory framework for community-based NRM		Address gaps in the legal and regulatory framework for community-based natural resource management and correct the inconsistencies between the different forest and environment-related laws (GELOSE, the forest law and the land tenure law).	Strengthen the capacity of the state, both central government and regional services, to support community-based natural resource management.	Help address the financial constraints of VOIs and municipalities through supporting expansion of performance-based payment schemes, taking for example advantage of REDD+ projects and programs.	MEDD, NGOs, CSOs (TAFO MIHAAVO, AVG,...)
Strengthen governance arrangements for ILM		Promote institutional mechanisms to facilitate coordination between CTD and STD.	Strengthen capacity of MEDD, MAL, and MWSH to apply land-use planning instruments. Strengthen capacity of CTD and STD for land-use planning.	Promote the use of land-use planning instruments and other institutional mechanisms in World Bank operations.	MATSF, MEDD, MINAE, MEAH, Governors of regions, STD, CTD, Projects: Mionjo, PADAP, Madagascar Rural Livelihoods Productivity and Resilience Project

Policy Objective	Instruments				Implementing Agencies
	Assessment	Policy and Regulatory Reform	Capacity Building	Investment	
Support expansion of fuelwood lots and plantations	Develop strategy to incentivize private sector investment in fuelwood/ charcoal plantations, including large scale productive forestry. Examine potential for greater value creation from charcoal plantations for industries.	Strengthen enforcement mechanisms to limit illicit trade, including through use of satellite-monitoring. Promote producer cooperatives to build economies of scale for community woodlots.		Increase supply of seed stock, and train farmers on agro-forestry practices. Finance grants and provide other financial incentives, including through use of carbon finance, for fuelwood plantations and community woodlots.	MEDD, MEH working with partners such as GIZ, WWF, Fanalamanga, Should consider also companies using woods as source of energy, such as companies in textiles. Projects: Mionjo, PLAE, Madagascar Rural Livelihoods Productivity and Resilience Project
Support expansion of efficient fuelwood stoves and other clean cooking solutions	Further assessment of potential for local production ethanol (sugarcane) including opportunity cost of agricultural land use, and options for expansion of biogas digesters.			Provide financing, including through use of carbon finance, for efficient stoves; integrate into ongoing landscape programs; Continue and expand financial incentives for planting sugarcane and local production of ethanol (carbon finance) and provide incentives for adoption of ethanol stoves;	MEDD, MEH, MICC, Centre Malgache de la Canne et du Sucre (CMCS), CT-PNEC Project: MG Clean cooking project, ADES, OPEC funds implementing partners.

Note: Recommendations in green are for implementation in the short term (1-3 years); in blue for the medium term (3-5 years); and in red for long term (5-10 years).

Photo credit : Pierre-Yves Babelon/Shutterstock.com

3 BLUE ECONOMY

"The Blue Economy is sustainable use of ocean resources for economic growth, improved livelihoods and job creation, while preserving the health of ocean ecosystems." World Bank (2021) definition.[75]

MADAGASCAR'S OCEAN ASSETS

59. **Madagascar has vast and biodiversity-rich coastal and marine natural assets.** Madagascar is the fifth largest island in the world with an EEZ of over 1.22 million square kilometers, an area nearly double that of its landmass. The country has the longest coastline in Africa – 5,600 km – and its EEZ is the fourth largest,[76] following South Africa, Seychelles, and Mauritius. The country's location is unique, exposed to the open Indian Ocean on one side and to the protected waters of the Mozambique Channel on the other, providing a rich diversity of marine habitats and ecosystems, and supporting diverse marine flora and fauna. Over 250,000 hectares of mangroves on the west coast provide fish nurseries, carbon storage and coastal protection, and timber; close to half a million hectares of coral reefs in the west, northwest, and northeast and inshore coastal areas host a high diversity of fish resources important to coastal communities. The waters of Madagascar supports a large diversity of fisheries, including for crustaceans (e.g., shrimp and crab), sea cucumber, demersal fish (e.g., groupers and snappers), small pelagics (e.g., sardines and anchovies) and large pelagics, including all main tropical tuna species. The country's waters, however, only benefit from the effects of an upwelling in its southern-most part and as a result, the marine ecosystems of Madagascar, while rich in biodiversity, are relatively less productive.

75 World Bank, 2021. Riding the Blue Wave: Applying the Blue Economy Approach to World Bank Operations (English). Washington, D.C.: World Bank Group. Available at: http://documents.worldbank.org/curated/en/099655003182224941/P16729802d9ba60170940500fc7f7d02655

76 The surface of 1,812,300 km² includes both the EEZ and the Territorial Waters of Madagascar.

60. **This considerable marine natural capital, however, is threatened by climate change, pollution, overexploitation, and other anthropogenic pressures.**Coastal habitats are important economically to Madagascar, providing many benefits and services ranging from important fish nursery grounds and habitats to tourist destinations, carbon storage and nature-based solutions for coastal protection. While annual trend data is not available for key habitats, various studies provide insights into significant changes that have been observed over the last few decades. These studies indicate an overall decline in the area and/or quality of mangroves, coral reefs, seagrass beds, and beach areas.

MADAGASCAR'S OCEANIC SECTORS

61. **Madagascar has yet to fully tap into the potential contributions of its marine natural capital to economic development.** The Malagasy ocean economy is only just starting to develop, and is primarily focused on marine-related exports – primarily shrimp exports which represented 3.4 percent of the total value of exports in 2020.[77] Tourism and shipping services are relatively underdeveloped (Bolaky, 2022[78]).

FISHERIES AND AQUACULTURE

62. **The fisheries sector plays a leading role in the country's economy.** With an annual production capacity of US$750 million, equivalent to more than seven percent of the national gross domestic product and a contribution of 6.6 percent to the total exports, the sector is an important contributor to economic development. Fisheries and aquaculture production totaled 124,537 tons in 2020, with marine fisheries and aquaculture contributing 85 percent of the total.[79] This accounts for approximately one percent of the total fisheries production in Africa, and around 10 percent of the production in the region. Small-scale fisheries produced 72,000 tons in 2020 and provided livelihood support to coastal communities. Overall, marine catches in Madagascar steadily increased from 1950 to 2007 when they peaked at almost 120,000 tons, followed by a decrease until 2015 when they fell to below 80,000 tons. In 2017, marine catches reached their maximum at above 120,000 but have been declining again ever since (Figure 3.1).

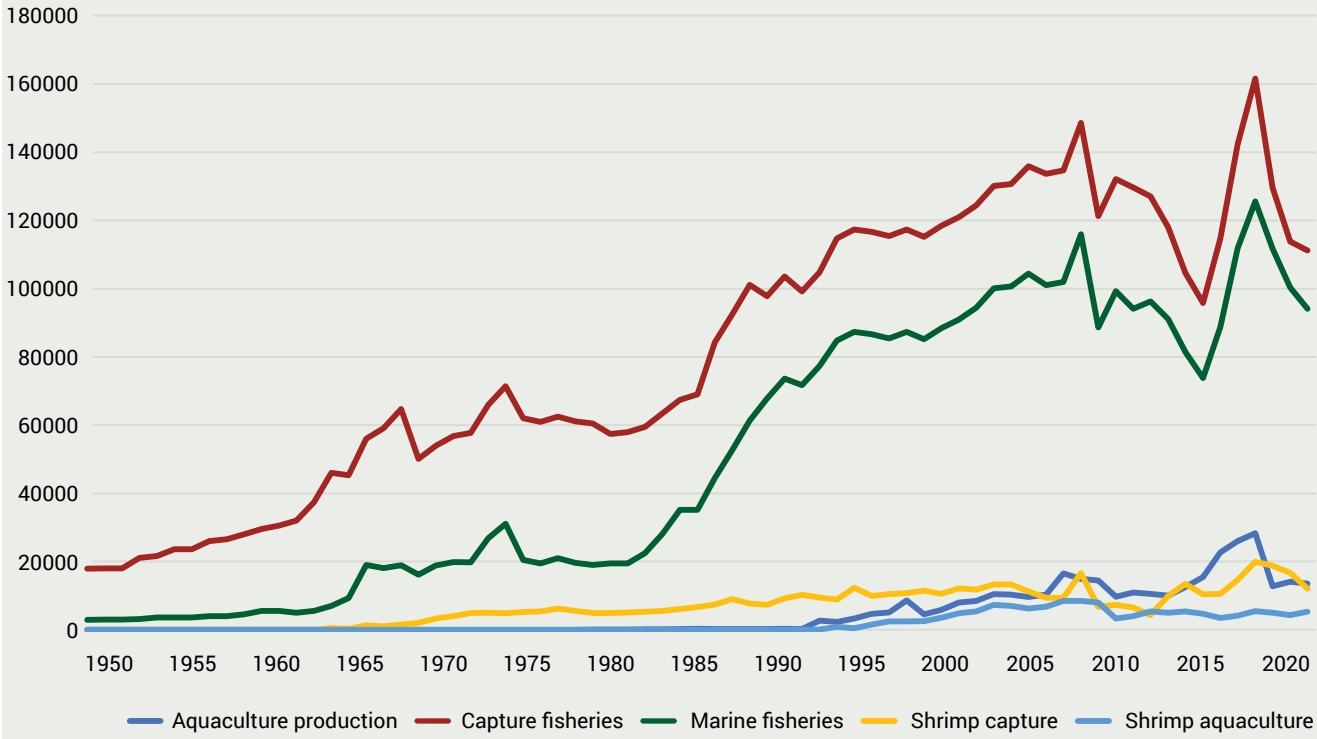
63. **Madagascar's marine fisheries resources are likely to be fully overexploited in most coastal areas.** There is evidence of overfishing in all segments of the sector. In the Menabe region, research has shown that within the small-scale fishery, for 13 of the 20 most common species, fishing mortality exceeds natural mortality and a large proportion of fish are caught before reaching sexual maturity.[80] Within the domestic industrial shrimp fishery, landings were over 7,000 tons from 1986 to 2004, with a peak in 2009 to around 9,000 tons, but have decreased by approximately 50 percent since the mid-2000s and are now stable between 3,000 and 4,000 tons annually.[81] In the offshore tuna fisheries, the Indian Ocean Tuna Commission has assessed the Indian Ocean yellowfin tuna stock as overfished since 2015, and both bigeye and albacore Indian Ocean tuna stocks as subject to overfishing[82] (IOTC, 2022).

64. **Marine resources are exploited by industrial, semi-industrial, artisanal, and traditional fishing fleets operating inshore and offshore.** Fisheries activities range from subsistence to commercial, by both domestic and foreign operators. Domestic catches are made up predominantly of finfish, shrimp and various invertebrates, while foreign catches are made up largely of tuna, billfish and shark.

65. **The COVID-19 pandemic has affected the sector, in particular small-scale fisheries and coastal communities.** During the pandemic, restrictions on movements to urban centers and within regions, curfews and lockdowns have all affected the fishing sector, in particular small-scale fishers, fishmongers, and other economic actors in the sector. In 2020, the demand for fish, especially for export and the tourism market was significantly reduced, possibly providing some stocks the opportunity to recover. While marine aquaculture

77 OEC, 2021. Madagascar Country Profile. Available at: https://oec.world/en/profile/country/mdg
78 Bolaky, B., 2017. Operationalising Blue Economy in Africa: The Case of South West Indian Ocean. ORF Issue Brief No. 398.
79 FAO Statistics. Fisheries and Aquaculture. Available at: https://www.fao.org/fishery/en/statistics
80 Gough et al., 2020.
81 SWIOFISH, 2019. Rapport final « Appui à la réalisation du projet d'amélioration de la pêcherie crevettière à Madagascar » (DP N°002/17-MRHP/SG/UGP-SWIOFish2 Crédit N° Q979).
82 IOTC, 2022. Status Summary for Species of Tuna and Tuna-like Species under the IOTC Mandate, as well as other Species Impacted by IOTC Fisheries. Available at: https://iotc.org/science/status-summary-species-tuna-and-tuna-species-under-iotc-mandate-well-other-species-impacted-iotc

Figure 3.1. Madagascar Overall Capture Fisheries, Marine Fisheries and Aquaculture Production (tons) from 1950 to 2020



Source: FAO, 2022.

production is much lower than that of marine capture fisheries, its trend shows an overall increase, with the COVID-19 pandemic having impacted production only slightly.

66. **Accurate fisheries statistics are essential for effective fisheries management.** While reliable fisheries are still lacking, Madagascar is currently using new and innovative systems to improve data collection. For small-scale fisheries, an app-based system is currently being deployed in coastal regions, allowing data to be compiled in near real-time and compiled in a central database at the ministry in charge of fisheries. In addition, Electronic Reporting Systems (ERS) are being deployed onboard industrial fisheries targeting shrimps and tuna.[83]

67. **The sector is an important source of livelihoods, employing 170,000 people directly and 300,000 indirectly, and supporting an estimated 1.5 million people.** These numbers, however, underestimate the real importance of the sector to local livelihoods, as a significant number of households practice subsistence or seasonal fishing and are not captured accurately in official statistics. Many of the country's food insecurity hotspots are found in coastal areas, highlighting the role that fisheries and coastal resources play for vulnerable communities as a means of subsistence and for food security. The total economic value of the fisheries sector is not known precisely, both because of gaps in official statistics and because so much activity in the sector is either illegal or unreported.

Marine Ecosystem Services

68. **Madagascar's marine and coastal ecosystems provide direct and indirect economic benefits.** These ecosystems provide a variety of services such as provision of fish, coastal erosion control, carbon sequestration and tourism. Current marine and coastal ecosystem services from five

83 The deployment of these systems is supported by the World Bank Second South West Indian Ocean Fisheries Governance and Shared Growth Project in Madagascar.

selected ecosystems in Madagascar —- coral reefs, mangroves, seagrass beds, wetlands, and beaches — have been estimated at US$192 million per year. If these ecosystems, however, were restored and conserved, these ecosystem services could double and increase to over US$337 million annually.[84] The region provided the most ecosystem services is Diana.

69. **Madagascar has abundant mangroves and seagrass ecosystems.** Mangroves in Madagascar represent around two percent of the global total,[85] and current mangrove coverage in Madagascar is approximately 2,600 km^2 (Global Mangrove Watch, 2016).[86] Mangrove cover declined by around 14 percent between 1990 and 2000,[87] but since 1996 trends in the total cover of mangroves have remained relatively stable. Decline of cover in the '90s was mostly driven by increased sedimentation from upstream deforestation and over-farming, conversion of aquaculture ponds and urban expansion.[88] The slowdown in mangrove loss since the early 2000s is likely due to efforts to better manage, protect, and restore mangroves, including through the introduction of government regulations.[89] Furthermore, Madagascar's NDC (2016)[90] set an ambitious target of restoring over 150,000 ha of forests, including mangroves, by 2030 and restoration activities by the ministry in charge of fisheries and Blue Economy and the Ministry of Environment, as well as by NGOs and the private sector, are ongoing.

70. **Mangroves provide valuable economic benefits.** Mangroves were estimated to provide over US$82 million of Total Economic Value for the country, an average of US$578 per hectare per year (WWF, 2021), and are a rich source of blue carbon.[91] This includes US$38 million in provisioning services, US$36 million in regulating services, US$8 million in cultural services and US$0.38 million in supporting services. Revised estimates of mangrove service suggest a value of US$110 million per year, which could increase to US$186 million if mangroves were restored and sustainably managed. Globally, it is estimated that mangroves can sequester six to eight mg CO_2 per ha (tons of CO_2 equivalent),[92] which would suggest that the potential for carbon storage in Madagascar could range between 15,000 and 20,000 mg CO_2.

71. **Seagrass beds are estimated to cover between 2000 and 4500 km^2 in Madagascar, but lack of available data prevents a precise assessment.** In addition to providing fish habitats, it is estimated that seagrass beds can store up to 140 mg CO_2 per hectare[93,94] around 15 times more than mangroves. Services from seagrass beds were valued at US$15.9 million annually, with the potential to increase to over US$27 million if restored and conserved, though these estimates are subject to large uncertainties due to date constraints.

84 These values are likely to be an underestimated, given that they only include five selected ecosystems, and because for a number of regions in the southern parts of Madagascar, in particular Androy, Anosy, Atsimo-Antsinana, Vatovavy and Fitovinany, the selected ecosystems are virtually absent. Open-water non-reef fishery were not included in the analysis, and data are lacking or incomplete on tourism and sandy beaches.

85 Western Indian Ocean Mangrove Network. Mangroves of Madagascar. Available at: http://wiomn.org/mangroves-of-madagascar/#:~:text=Madagascar%20has%20one%20of%20the,2%25%20of%20the%20global%20distribution

86 Global Mangrove Watch. Madagascar Country Profile. Available at: https://www.globalmangrovewatch.org/country/MDG?map=eyJiYXNlbWFwIjoibGlnaHQiLCJ2aWV3cG9ydCI6eyJsYXRpdHVkZSI6LTE5LjgzNTg4MDUxMzE1OTM0LCJsb25naXR1ZGUiOjM0LjQ4NzM1MTE1MTcyMTU0LCJ6b29tIjo0LjA3OTg1ODY4Nzc0NTMyNCwiYmVhcmluZyI6MCwicGl0Y2giOjB9fQ%3D%3D

87 Jones, T., L.Glass, S. Ganhi, , L. Ravaoarinorotsihoarana, A. Carr, L. Benson, . R. Ratsimba, C. Giri, D. Randriamanatena, and G. Cripps. 2016. Madagascar's Mangroves: Quantifying Nation-Wide and Ecosystem Specific Dynamics, and Detailed Contemporary Mapping of Distinct Ecosystems. Remote Sensing 16(8):106

88 Giri, C., & Muhlhausen, J. 2008 Mangrove forest distributions and dynamics in Madagascar (1975–2005). Sensors, 8(4), 2104-2117.

89 Republic of Madagascar, 2014. Ministerial decision no. 32100/2014 bans the cutting of mangrove wood. Available at: http://extwprlegs1.fao.org/docs/pdf/mad147304.pdf

90 Republic of Madagascar, 2016. Madagascar's Intended Nationally Determined Contribution. Available at: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Madagascar%20First/Madagascar%20INDC%20Eng.pdf

91 WWF, 2021. Policy Brief for Madagascar. Available at: https://www.mangrovealliance.org/wp-content/uploads/2021/11/A4-document-Policy-brief-Madagascar-1-3.pdf

92 The Blue Carbon Initiative. About Blue Carbon: What are blue carbon ecosystems? Available at: https://www.thebluecarboninitiative.org/about-blue-carbon#:~:text=It%20is%20estimated%20that%20the,observed%20in%20mature%20tropical%20forests%20*

93 Mcleod, E. et al., 2011. A blueprint for blue carbon: toward an improved understanding of the role of vegetated coastal habitats in sequestering CO2. Front. Ecol. Environ. 9, 552–560 (2011).

94 Fourqurean, J. W. et al., 2012. Seagrass ecosystems as a globally significant carbon stock. Nat. Geosci. 5, 505–509 (2012).

72. **The potential to monetize blue carbon services remains untapped.** Madagascar drafted a decree declaring the government as sole owner of all emission reductions and removals generated, with exclusive right to trade any carbon credits.[95] At this point, however, no attempt to trade these rights has yet been made.[96] A moratorium on the sale of carbon credits is in place, which has prevented the issuance of credits in a community-run protected area for mangroves.[97]

73. **Estimates of coral reef cover vary extensively, with an estimate of 3,934 km² widely accepted (Burke et al. 2011).** Overall, coral cover has declined since 1998, with the major bleaching event of 2015 to 2016 resulting in more than 50 percent coral mortality in 20 percent of monitoring sites.[98] For this study, ecosystem services provided by coral reef was valued at US$42 million per year, with the potential to increase to over US$75 million if restored and conserved.

74. **The health of coastal and marine habitats is increasingly at risk.** The west coast of Madagascar is vulnerable to coastal erosion with an estimated loss of 7-8 mm per year in some areas.[99] Significant storms will likely accelerate coastal erosion, as seen in 1997 when wave erosion removed 5.71 to 6.54 m of shoreline. Overall, Madagascar has an annual net loss due to shoreline erosion from coastal development, storms, and sea level rise.[100] The loss of these ecosystems, and the services they provide, will have significant economic impacts on all coastal and marine sectors and communities. Madagascar's coastal and marine ecosystems are under threat from climate change and pollution, including from plastics, and other anthropogenic pressures. Climate change will impact marine and coastal habitats in many ways: (i) increasing sea surface temperatures will change oceanic conditions, affecting fish abundance and distributions and threatening food security and livelihoods. It will also affect coastal habitats such mangroves as well as coral reefs through increases in frequency and intensity of coral bleaching events, affecting the capacity of these ecosystems to provide services such as fish nurseries or habitats, as well as nature-based solutions against coastal degradation; (ii) sea level rise will increase coastal erosion, degrading beaches and ultimately threatening coastal industries, such as tourism, and the jobs they provide, and will weaken the coastal protection function of mangroves; and (iii) increasing frequency and intensity of climate events (e.g., cyclones and floods) will increase erosion and damage coastal assets. Pollution, including plastic pollution, from upstream activities or other external sources, can impact coastal habitats and ecosystems and the species that depend on them. Habitat destruction and pollution limit the capacity of compromised ecosystems to deliver key services such as fisheries and coastal protection and to provide cost-effective nature-based solutions to address the impacts of climate change.

Tourism

75. **Tourism is a growing sector in Madagascar and marine tourism appears to be increasingly attractive to visitors.** Particularly when compared to neighboring countries in the region, the potential for tourism growth is significant in Madagascar (Figure 3.2). A visitor survey conducted in 2012[101] indicated that 63 percent of tourists in Madagascar spend time on the coast, broadly

95 The REDD+ Decree (e N° 2021-1113 of October 20, 2021 on the regulation of access to the forest carbon market) sets the legal basis of the benefit sharing mechanism and notes that carbon benefits are considered as "public resources" in Madagascar and as such they are subject to the specific provisions of applicable Malagasy law. Available at : https://documents1.worldbank.org/curated/en/142031644397335762/pdf/Advanced-Draft-Benefit-Sharing-Plan-ER-Program-Atiala-Atsinanana.pdf

96 World Bank, 2022. Advanced Draft Benefit Sharing Plan: ER Program Atiala-Atsinanana (English). Washington, DC: World Bank Group. Available at: http://documents.worldbank.org/curated/en/142031644397335762/Advanced-Draft-Benefit-Sharing-Plan-ER-Program-Atiala-Atsinanana

97 Rakotomahazo et al., 2021. Community Perceptions of a Payment for Ecosystem Services Project in Southwest Madagascar. A Preliminary Study. Land 10: 597.

98 GCRMN. 2020. Status of Coral Reefs of the World: Chapter 5. Status and trends of coral reefs of the Western Indian Ocean region https://gcrmn.net/wp-content/uploads/2022/02/Chapter-5.-Status-and-trends-of-coral-reefs-of-the-Western-Indian-Ocean-region.pdf

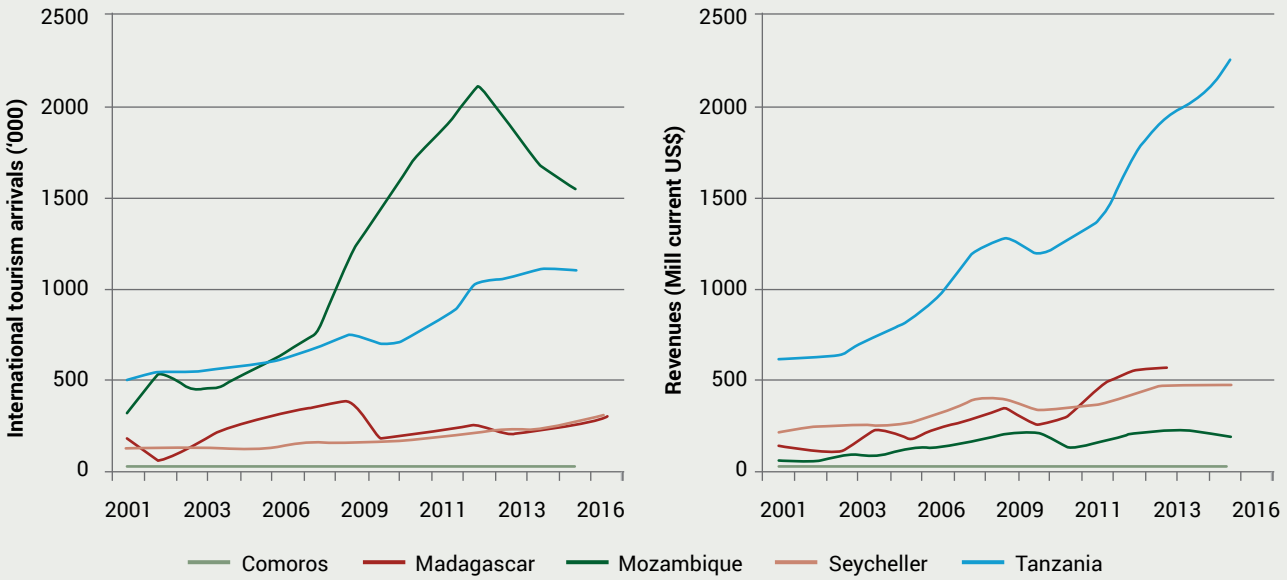
99 Luijendijk, A., G. Hagenaars, R. Ranasinghe, F. Baart, G. Donchyts, S. Aarninkhof. 2018.The State of the World's Beaches. SCIENTIFIC REPOrTS | (2018) 8:6641 | DOI:10.1038/s41598-018-24630-6

100 Mentaschi L., M. Vousdoukas, J. Pekel, E. Voukouvalas, L. Feyen. 2017. Global long-term observations of coastal erosion and accretion. SCiEntiFiC REPOrTS | (2018) 8:12876 | DOI:10.1038/s41598-018-30904-w

101 World Bank Group, 2013. "MADAGASCAR Tourism Sector Review: Unlocking the Tourism Potential of an Unpolished Gem." Washington, DC: World Bank Group. Available at: https://openknowledge.worldbank.org/handle/10986/16709

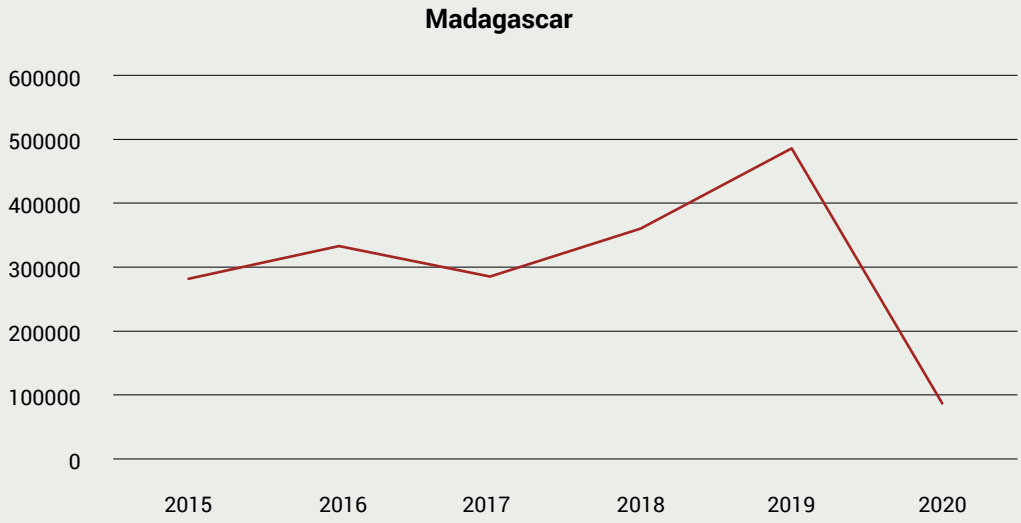
concentrated in four areas: Nosy Be, Antsiranana, Sainte Marie, and Toliara. The COVID-19 pandemic significantly impacted tourist arrivals in Madagascar, and the impact was particularly significant for destinations that rely heavily on marine and coastal ecosystems, such as Nosy Be and Sainte Marie (Figure 3.3), though slow improvement appears to be underway, especially given the recent reopening of Madagascar's borders in March 2022.

Figure 3.2. International Tourist Arrivals and Revenue in Countries Bordering the Mozambique Channel



Source: Ghermandi et al. 2019[102]

Figure 3.3. Trend of Tourist Arrivals in Madagascar from 2015 to 2020[103]



Source: World Bank, 2022.

102 Andrea Ghermandia, A., D.Oburab, C. Knudsenc, P. Nunesd., 2019. Marine ecosystem services in the Northern Mozambique Channel: A geospatial and socio-economic analysis for policy support Ecosystem Services 35:1–12.

103 World Bank, 2022. The World Bank in Madagascar. Available at: https://www.worldbank.org/en/country/madagascar/overview#1

76. **An interesting example of Malagasy marine tourism is whale shark watching as well as other megafauna (e.g., whales, manta rays) in Nosy Be, which almost doubled from 2015 to 2019.** Revenue from the three-month whale shark watching season has been estimated at US$1.5 million.[104] Although this is a small and relatively niche sector in a broader, US$500 million sector, it does provide an important source of revenue for the local population engaged in tourism. This rapid growth in the sector has led the operators to identify the need for improved management of such activities to avoid overcrowding, provide regulations and training, and to bolster the sustainability of this activity.[108]

77. **The cruise tourism segment is limited in Madagascar.** There are plans to try and capture a share of cruise tourism by expanding or upgrading selected ports (Tôlanaro and Saint Marie), though the environmental and social impacts of such developments need to be fully and properly assessed. The current state of ports (discussed below), as well as relatively low service standards compared to other countries along the same cruise routes are likely to limit any development of this segment.

78. **While accurate estimates of the current value of marine tourism across Madagascar are not available, there is information at the regional scale.** Economic modeling from a study of the Northern Mozambique Channel (NMC) ecosystem, which includes the west coast of Madagascar, indicated that a one percent decrease in the number of Marine Protected Areas (MPAs) would result in decreases in the number of international and domestic arrivals of, respectively, 1.44 percent and 0.3 percent. A reduction by one percent in the length of beaches would result in 0.24 percent and 2.47 percent decreases in the number of international and domestic arrivals, respectively. Additional environmental degradation such as reductions in wetland areas, lower bird and mammal populations, and bleached coral reef areas might have further negative impacts on the number of coastal arrivals. In aggregate, the monetary estimate of coastal tourism values in the NMC region amounts to US$5198.5 million annually.[106] This study highlights the importance of healthy ecosystems to support a vibrant tourism sector in Madagascar.

Maritime Transport/Shipping

79. **Madagascar is home to 17 ports, six of which are open to international traffic.[90]** In 2020 the value of transport services trade was US$1.4 million, with 40 percent accounting for transport of food. The national fleet consists of 27 flagged vessels with a total of 3,000 DWT (UNCTADStat, 2022).[105] The two main ports are located in Toamasina on the west coast and Tôlanaro in the southeast, with 75 percent of international freight moving through Toamasina. This is the country's largest port facility, serving several large urban areas and in particular Antananarivo. Other secondary ports are mostly used for cabotage around the country, as well as in the subregion, to transport goods and passengers.[106] Ports are characterized by infrastructure obsolescence, lack of maintenance and insufficient modernization. 82 As a result, port performance and capacity remain small compared to other ports in the region. Despite its geostrategic location in the Indian Ocean and its proximity to important shipping lines, Madagascar is hampered by its low competitiveness, both regionally and internationally, which impacts maritime transport, international trade, and maritime tourism.

POTENTIAL NEW OCEANIC ECONOMIC SECTORS

80. **The coast and EEZ of Madagascar hold considerable potential for emerging sectors such as mariculture, offshore renewable energy, and marine biotechnology.**

Mariculture

81. **Currently, mariculture remains underdeveloped with only a few farms in operation, but has significant growth potential.** Mariculture in Madagascar comprises three distinct components:

104 Ziegler, J., S. Diamant, S. Pierce, R. Bennett, J. Kisaka., 2021. Economic Value and Public Perceptions of Whale Shark Tourism in Nosy Be, Madagascar. Tourism in Marine Environments, 16(3):167-182.

105 UNCTADStat, 2022. Maritime Profile: Madagascar. Available at: https://unctadstat.unctad.org/countryprofile/maritimeprofile/en-gb/450/index.html

106 Logistics Capacity Assessment. Madagascar Port Assessment. Available at: https://dlca.logcluster.org/display/public/DLCA/2.1+Madagascar+Port+Assessment

shrimp, seaweed, and sea cucumber. Economically, the most important mariculture sector is shrimp farming, initiated in 1992 and with a production of 5,420 tons in 2020 worth over US$50 million.[107] Much of the production is exported, and generated 3.5 percent of export value in 2019 (IDDRI, 2019).[108] Madagascar is a significant producer in east Africa, and the only producer of farmed organic shrimp in the world. So far, much of this production has been carried out in mangrove areas, with some historical loss due to mangrove conversion to shrimp ponds.

82. **More recently, sea cucumber and seaweed cultivation has started, mostly in the southwest and involving local communities.** Seaweed production in Madagascar has now reached 17,410 tons (2,300 t of dried product) and sea cucumber production (10 t of dried product) (SNDAM, 2021). Both commodities provide income for many families, and particularly women who represent 50 percent of the labor force. An evaluation by NORAD of aquaculture projects in southwest Madagascar from 2016 to 2019 concluded that the introduction of seaweed and sea cucumber farming increased family incomes by US$55.5 per month for sea cucumber and US$1.30 per day for seaweed.[109] Although these figures remain modest, many of the beneficiaries were laborers who had previously made US$1 per day or were unemployed. Both forms of mariculture can be sustained, with minimal impacts, if best practices are implemented, including appropriate siting, avoiding mangrove harvesting and conversion, and limiting loss of equipment. Seaweed production also has considerable potential, especially given that it contributes to carbon storage, improving water quality and reducing pollution.

Offshore Renewable Energy

83. **Madagascar's current energy generation (1,849 GWH) is land-based, with much of it generated by fossil fuels and hydro-electric facilities, and solar accounting for less than one percent of production** (AFDB 2021).[110] This capacity, combined with poor distribution infrastructure, means that only 15 percent of the population has access to the national electricity grid, and five percent in rural areas. Off-grid infrastructure provides additional access for many, but this remains largely small-scale.[111] Renewable energy, including marine renewable energy, therefore has considerable potential to improve access for many more.

84. **Wind potential is highest in the northern part (around Antsiranana) and the southern part (around Taolagnaro), with wind speeds suitable for electric production more than 7m/s (50 m high).[112]** The current potential for offshore wind energy in Madagascar is estimated at 154 GW, with 45 GW from fixed infrastructure and 109 GW from floating.[113] A recent study[114] examined six sources of offshore renewable energy and concluded that Madagascar has high potential for wave and wind energy, and more moderate potential for ocean current, Ocean Thermal Energy Conversion (OTEC) and Floating Photovoltaic Power (FVP).

107 FAO, 2022. Fishery and Aquaculture Statistics. Global aquaculture production 1950-2020 (FishStatJ). In: FAO Fisheries and Aquaculture Division. Rome: FAO. Available at: www.fao.org/fishery/statistics/software/fishstatj/en

108 Nandini Agarwal, Chiara Bonino, Ana Deligny, Luisa El Berr, Charlotte Festa, Manon Ghislain, Katarina Homolova, Ana Kuhn Velasquez, Ilyia Kurtev, Alexandra Oliveira Pinto, Vincent Virat, Julia Serban-Penhoat and Marie Thomas, 2019. Getting the Shrimp's Share: Mangrove Deforestation and Shrimp Consumption, Assessment and Alternatives. Available at: https://www.iddri.org/sites/default/files/PDF/Publications/Catalogue%20Iddri/Rapport/Getting%20the%20shrimp%20s%20share.pdf

109 Joseph Mario Ray and Volaniaina Robsona, 2019. An Aquatic Industry for Madagascar: Increased and Diversified Sources of Revenue in Southwest Madagascar (2016 – 2019). Available at: https://www.norad.no/globalassets/publikasjoner/publikasjoner-2020/ngo-evalueringer/final-evaluation-report-an-aquaculture-industry-for-madagascar-increased-and-diversified-sources-of-revenue-in-southwest-madagascar-2016--2019.pdf

110 African Natural Resources Centre, 2021. Assessing the potential of Offshore Renewable Energy in Africa. A Background Paper. African Development Bank, Abidjan, Cote d'Ivoire.

111 Republic of Madagascar, 2014. Expression of Interest to participate in the Scaling Up Renewable Energy In Low Income Countries Program. Available at: https://www.climateinvestmentfunds.org/sites/cif_enc/files/meeting-documents/madagascar_eoi_0.pdf

112 Republic of Madagascar, 2014. Expression of Interest to participate in the Scaling Up Renewable Energy In Low Income Countries Program. Available at: https://www.climateinvestmentfunds.org/sites/cif_enc/files/meeting-documents/madagascar_eoi_0.pdf

113 World Bank, 2020. Offshore Wind Technical Potential in Madagascar. Available at: https://documents1.worldbank.org/curated/en/879871586853505752/pdf/Technical-Potential-for-Offshore-Wind-in-Madagascar-Map.pdf

114 Technavio, 2022. Blue Biotechnology Market by Application and Geography – Forecast and Analysis 2021-2025. Available at: https://www.technavio.com/report/blue-biotechnology-market-industry-analysis&nowebp

Marine Biotechnology

85. **Globally, marine biotechnology is expected to grow by US$2.5 billion by 2024.**[114] Africa's marine waters are a potential source of organisms with biotechnical applications.[115] Several surveys in Madagascar identified 91 species of algae, 10 species of seagrass, 276 species of hard coral, 271 species of fish and 19 echinoderms, respectively.[116] One of Madagascar's longest bioprospecting projects screened marine plants and microorganisms for potential medical development (ICBG, 1998-2013). The project contributed to establishing the Ambodivahibe Marine Protected Area.[117] Potential blue bioeconomy research could be undertaken by the National Centre for Oceanographic Research and the University of Antananarivo,[118] but such endeavors will require the development of a supportive regulatory framework.

MAXIMIZING THE VALUE OF THE OCEAN ECONOMY: A BLUE ECONOMY APPROACH

86. **Madagascar's marine and coastal areas deliver important economic and social benefits, both nationally and at the community level.** There is also, however, potential to deliver considerably more benefits, not only through the development of new sectors, such as renewable energy and mariculture, but also by ensuring that the development of existing oceanic sectors is more sustainable. To that end, Madagascar should consider speeding up its transition to a Blue Economy approach, where the development of current and emerging marine sectors is integrated, and where ecosystem health and services are sustained or improved, resulting in an economic growth that contributes to improved livelihoods and jobs. The integrated approach to the Blue Economy provides a framework to deliver economic and social benefits with minimal impact on marine and coastal resources, or in some cases restoration. These benefits are not just accrued for coastal communities but also for urban and inland rural communities.

87. **The Blue Economy approach in Madagascar should be based on healthy and sustainably managed coastal and marine ecosystems.** Existing and new sectors of the Malagasy Blue Economy depend on or impact the health of coastal and marine ecosystems, which are currently degraded and under threat from anthropogenic pressures and climate change. Sustainably managing these ecosystems is essential for the development of the Blue Economy approach, and associated with their restoration, the value of the ecosystem services that they provide could at least double. The expansion of management systems fully involving coastal communities, such as manager transfers, co-management could be scaled-up at the national level. This could make the Blue Economy a pillar of the Malagasy economy, while improving the well-being of coastal communities.

88. **Progress in transitioning to a Blue Economy in Madagascar has been relatively slow so far, for several reasons, including the COVID-19 pandemic.** The benefits of a Blue Economy approach in Madagascar are important and can be achieved in many of the current and emerging ocean sectors (Table 3.1). Some of these benefits will come from the introduction of new policies and regulations or the strengthening of existing ones. Other benefits will result from the creation of enabling conditions for public or private sector investment in the various sectors, and from innovative financing, increased knowledge, training, and better access to finance and technologies. Key to realizing these benefits is having political commitment, a strategy, or policy framework built on Marine Spatial Planning (MSP), and a private sector willing to invest when the enabling environment has been developed. MSP is an important component of this transition because it can help accurately value marine and coastal ecosystems and the services they provide, facilitate conflict resolution between different users, and provide a degree of certainty to investors to access marine resources or areas.

115 Wetaya, 2022. Blue economy seen as catalyst for Africa's economic resurgence. Alliance for Science. Available at: https://allianceforscience.cornell.edu/blog/2022/02/blue-economy-seen-as-catalyst-for-africas-economic-resurgence/

116 Obura D, Di Carlo G, Rabearisooa A and Oliver T, 2011. "A Rapid Marine Biodiversity Assessment of the Coral Reefs of Northeastern Madagascar, Bulletin of Biological Assessment." Fort Dauphin.

117 USDA, 2013. Biodiversity Conservation and Drug Discovery in Madagascar. Available at: https://reeis.usda.gov/web/crisprojectpages/0215326-biodiversity-conservation-and-drug-discovery-in-madagascar.html

118 Dyer, J., 2019. Ensuring Ocean Sovereignty, Marine Resilience and Investment Opportunities for Africa and its Indian Ocean Rim Island Developing States: The Economic Potential of Marine Biotechnology under Climate Change for Investors and Other Stakeholders. Blue Economy Future.org.za.

Table 3.1. Distribution of the Benefits of Transitioning to a Blue Economy in Madagascar

	Main Current and Emerging Ocean Sectors					
Benefits	**Fisheries**	**Tourism**	**Shipping**	**Mariculture**	**Renewable Energy**	**Marine Biotech**
Improved livelihoods and jobs including diversification						
Safer working conditions						
Improved investment conditions and diversification						
Increased public-private investment partnerships						
Better food security and health						
Improved governance of marine resources						
Increased equitable rights to marine resources and areas						
Participation in decision making						
Enhanced sustainable food production						
Improved value chains						
Restored/enhanced coastal infrastructure						
Increase use of nature-based solutions						
Better access to energy from offshore renewables						
Reduced carbon emissions						
Improved climate resilience						
Enhanced climate adaptation						
Healthier marine ecosystems						
Better transboundary resource sharing						

Note: Darker cells indicate greater benefits.
Source: UNECA, 2016[119]

89. **The transition to a Blue Economy approach can be undermined if it is not well thought out and guided by a systematic and transparent strategy or framework.123** Possible risks include the marginalization of stakeholders and ultimate rejection of the necessary reforms, conflicts over space and access to resources, increased pollution or resource degradations, outsourcing of skilled labor, reduced investments, increased gender disparity, widening inequality, increased carbon emissions, increased climate vulnerability, maladaptation to climate change, and increased conflicts and bureaucratic complexity. The last two issues are important as they will affect the willingness of the private sector to invest.

INSTITUTIONAL STRUCTURE AND SUPPORT FOR A BLUE ECONOMY APPROACH IN MADAGASCAR

90. **The development of the framework of the Blue Economy in Madagascar began in 2015 with the formulation of the Blue Economy Policy Letter within the Ministry of Fisheries.**[120] While this policy letter was mostly focused on fisheries, it nevertheless set the country on a path toward a Blue Economy approach. In 2016, the government established the State Secretariat in charge of the Sea under the Prime Minister's office, followed by Decree N° 2017-936, establishing the National Framework for the establishment of the Blue Economy in 2017 and the drafting of a National Blue Economy Strategy in 2018.

119 UNECA, 2019. Africa's Blue Economy: A Policy Handbook. Addis Ababa, Ethiopia: UNECA.

120 Ministère des ressources halieutiques et de la pêche (MRHP), 2015. Lettre de Politique BLEUE. Available at: http://extwprlegs1.fao.org/docs/pdf/mad163970.pdf

91. **In 2018, the Government of Madagascar also benefited from direct support by the FAO to organize consultations with stakeholders, consolidate the strategy, and strengthen commitments from oceanic sectors.** Madagascar reiterated its commitment to the Blue Economy at the High-Level Oceans meeting in Nairobi in late 2018. Since then, the General Directorate of Presidential Projects has met with stakeholders in the Blue Economy to revitalize the National Committee of the Blue Economy (CNEB). In 2019, the Ministry in charge of Fisheries absorbed the General Secretariat of the Sea with the creation of the Directorate General for Oceans. In 2020, Decree N° 2020-158 created the Department of the Sea and Blue Economy under the Directorate General of Fisheries and Aquaculture within the Ministry of Agriculture, Livestock, and Fisheries. In August 2021, a dedicated Ministry for Fisheries and the Blue Economy was created.

92. **The political will to commit Madagascar to a Blue Economy approach has thus been clear and consistent.** To date, however, this political will has not yet translated into measurable action and more needs to be done, including with the growing support from development partners. The African Development Bank (AfDB) is currently supporting Madagascar in finalizing its Blue Economy policy and developing an associated investment plan. This plan will inventory potential innovative financing with recommendations to mobilize funds to support the promotion of the Blue Economy and identify the potential for investment in the Blue Economy in the 14 coastal regions. Several partners, including the World Bank, through the Second South West Indian Ocean Fisheries Governance and Shared Growth Project (SWIOFish2), are supporting MSP at the regional level.

OPPORTUNITIES AND CHALLENGES FOR A BLUE ECONOMY APPROACH

93. **An effective Blue Economy strategy provides the framework to enhance the sustainability of oceanic sectors development.** It does so by identifying best practices, prioritizing the sectors to integrate, and identifying the appropriate locations for development of future industries such as offshore renewable energy, aquaculture, tourism, and future ports for shipping. This Blue Economy lens, however, also needs to be applied to each individual oceanic sector.

Fisheries

94. **Many fisheries in Madagascar are overfished, but there are opportunities to improve the value of catches through better post-harvest handling and processing, and to diversify fishing activities,** including through synergies with the tourism sector (e.g., pesca-tourism/sports fishing). However, the bigger challenge to long-term sustainability in this sector is improved governance including accurate stock assessments to inform better management planning, and enforcement of fisheries regulations. Climate change, and the impacts it has on stocks and marine and coastal ecosystems, also needs to be front and center in the formulation or revision of fisheries management.

Tourism

95. **Marine tourism in Madagascar is underdeveloped and opportunities abound to diversify the sector.** Potential growth has been identified in wildlife tourism, diving (day and liveaboard) and cultural tourism. Many of the development challenges highlighted in Chapter 4 also apply to the marine tourism sector. Given the sector's high reliance on healthy oceans, a significant challenge is to ensure that marine pollution, including from marine debris, and water quality are well managed. Here again, the impacts of climate change threaten the sustainability of this sector, and planning needs to account for challenges such as coastal erosion, coral bleaching, and shifting species distributions. The integrated nature of the Blue Economy supported by MSP can support the needed response, for example, by facilitating synergies between tourism managers and coastal port and infrastructure managers, as well as disaster response agencies, to ensure tourism can recover quickly from cyclone events.

Maritime Transport

96. **If the necessary investments can be encouraged, Madagascar's ports could become regional trade hubs, leading to further port developments and trading.82** The potential for trans shipping and for bunkering of decarbonized fuels, such as ammonia, could put Madagascar at the forefront of new regional efforts to decarbonize shipping. As things currently stand, however, most ports are in need of major upgrading to be competitive in the region. These upgrades and expansions, in the context of the development of the Blue Economy,

must consider social concerns and environmental impacts on coastal ecosystems and their services as well as on other oceanic sectors. Here again, these risks can best be addressed through an integrated approach to managing marine and coastal resources, through MSP.

Mariculture

97. **The sector is clearly undeveloped and could be tapped to generate revenue — including for exports — to support livelihoods and improve food security.** Shrimp farming, in particular, could clearly be further developed, with a 2013 study estimating the potential for shrimp production at estimated at 58,000 tons per year. Increasing production, however, risks further impacting mangroves and even legislation and regulations currently on the books are not effectively implemented.112 Farming of other marine species such as sea cucumber and seaweed are in the early stages of development and the potential for expansion is considerable. This sector directly depends on healthy ecosystems, and given the need for extensive marine space for such operations, the potential for habitat degradation and conflicts with current and emerging sectors is also great. Further development should be considered within a broader Blue Economy approach, including relying on extensive MSP.

Offshore Renewable Energy

98. **The opportunities to develop offshore renewable energy are promising.** The challenges for the sector are in establishing the enabling conditions for private investment that delivers affordable energy and creates decent work opportunities, yet maintains marine ecosystem help and does not generate conflicts with other users of the same space. A Blue Economy approach can support the development of this sector, especially through a sector strategy that draws on MSP to best identify sites for new projects, thus building the enabling conditions for private sector investment. In addition, other social and environmental concerns must be addressed proactively.

Marine Biotechnology

99. **The potential for biotechnology applications from marine species in Malagasy waters is considerable.** A proactive strategy needs to be developed for the sector to establish the enabling conditions to attract necessary private sector investments. The experience of bioprospecting the terrestrial flora and fauna of Madagascar provides many lessons on developing such a strategy and building these enabling environmental conditions. As such, marine bioprospecting should be included in any Blue Economic strategy for the country.

RECOMMENDATIONS TO ADVANCE THE BLUE ECONOMY APPROACH

100. **Madagascar is already well engaged on a path towards a Blue Economy approach, with a view to managing and generating more benefits from its marine and coastal resources.** However, stronger cross-sectoral coordination and collaboration are required to make this vision a reality, including through extensive consultations involving all stakeholders, such as the private sector and coastal communities. The implementation of a Blue Economy approach requires a strengthened institutional setup to ensure that cross-sectoral coordination can take place effectively. At the sectoral levels, trade-off and compromise may be required since the development of one oceanic sector may limit the development of others. Early planning, including through MSP, can allow such policy decisions to be made early on and provide adequate guidance for public and private sector investments. A number of threats will likely hinder the development of the Blue Economy, including climate change and marine pollution, and these should be considered throughout development and implementation to adapt and mitigate their impacts.

121 Mamy Andriatiana, 2013. Field Report from Madagascar. SPORE. Available at: https://spore.cta.int/en/dossiers/article/shrimp-for-export-a-unique-strategy-sid03dfdc39e-2317-42b0-bf3e-d3977b452852

Table 3.2. Summary Table for Recommendations

Recommendation	Study/ Assessment	Legal/ Regulatory/ Policy Change	Capacity Building	Investment
Environmental Threats	Assess current state of marine pollution, including plastic, threatening coastal ecosystems	Review and strengthen relevant policies and regulation to reduce marine pollution including from land-based sources and to establish enabling conditions for a marine plastics circular economy	Strengthen capacity of private sector to uptake circular economy approach for marine plastics and to better manage plastic waste	Encourage public-private sector investments in marine plastics waste management and recycling
Blue carbon	Assess blue carbon storage in mangroves and seagrass beds to better protect them and leverage financial resources	Integrate blue carbon potential into next NDC revision		Identify emission reduction and removals markets for blue carbon credits
Review and amend regulatory frameworks to improve investment climates especially for emerging industries and to increase compliance and mitigating impacts on marine ecosystems	Assess the regulatory barriers to a) an integrated Blue Economy; b) the establishment of emerging sectors (e.g., marine renewable energy); c) compliance in key sectors	Draft appropriate regulations to address the barriers at national and subnational levels	Build capacity across the legal system to facilitate investments and to better enforce compliance within Blue Economy sectors at national and subnational levels	
Finalize, adopt and implement a Blue Economy (BE) strategy	Institutional functional review	Assess ways to strengthen the implementation of the BE strategy across sectors	Build state actor capacity to integrated management of marine sectors and implement BE strategy	Mainstream Blue Economy activities into marine sectors; Formulate Blue Economy progress monitoring system; Evaluation of BE strategy progress and effectiveness after 5 years
Review funding needs for Blue Economy coordination and monitoring and explore incentives and financing options aligned withblue finance principles	BE public expenditure review; Assess options and the regulatory changes needed for innovative financing and incentives for the uptake of Blue Economy activities and technologies	Mainstream funding for BE coordination and monitoring; Propose policy and regulatory changes to allow innovative financing mechanisms; Propose policy and regulatory changes to facilitate access to relevant incentives	Improve decision makers understanding of the benefits of the BE approach; Strengthen small-medium enterprise financial capacities to access to financing for BE activities	Explore impact financing; Establish long-term funding programs to foster BE entrepreneurship and innovation; Explore incentives to reduce pollution from urban and industrial sources; Explore incentives to improve or develop blue value chains

Recommendation	Study/ Assessment	Legal/ Regulatory/ Policy Change	Capacity Building	Investment
Formulate national MSP framework to guide subnational MSP efforts and link to sectoral planning with a focus on engaging the private sector	Assess the compatibility of existing sector plans with BE strategy	Draft national MSP framework to guide decision making and formulation of subnational plans; Review and make recommendations for revisions to key marine sector policies and regulations for better alignment and implementation of the BE Strategy	Build capacity with key sectors and stakeholders to effectively participate in planning and decision making aligned to Blue Economy approaches	Prepare and fund approved MSP implementation plans
Factor climate change in Blue Economy activities	Review and assess the impact of climate change on Madagascar's Blue Economy	Mainstream climate consideration as part of any regulatory review and revision	Build sector actor capacity to integrate climate change adaptation and mitigation measures into sector activities	Allocate resources to revise key sector strategies to address climate change impacts
Better understand the skills gap for Blue Economy sectors and formulate plans to fill the gaps	Undertake capacity needs assessment across key sectors		Explore the capacities of existing training institutes to implement skills strategy and related costs to public and private sector	Prepare and implement strategy to fill the knowledge gaps

Note: Where recommendations are in green they are for implementation in the short term (1-3 years; where they are in blue they are in the medium term (3-5 years).

Photo credit : Natia Tsiky

4 PROTECTED AREAS AND NATURE-BASED TOURISM

MADAGASCAR'S BIODIVERSITY: IMPORTANCE AND MAJOR THREATS

101. **Madagascar is one of the most biologically diverse places on the planet.** While the island is not exceptionally rich in the number of species, most of its plant and animal species are endemic:[122] more than 90 percent of plant species, a third of birds and all amphibians and lemurs are found nowhere else. In addition, the many endemic groups present on the island are ancient, having evolved from their closest relatives many million years ago[123] and therefore forming groups without any close relatives elsewhere. Madagascar is also large enough to have several very distinct biomes, allowing further species differentiation within the landmass. The island's flora and fauna have evolved not only under isolation but under very different conditions to mainland Africa, resulting in the globally unique ecosystems seen today.[124]

102. **Madagascar's marine biodiversity is also outstanding.** With 5,600 kilometers of coast – the longest in Africa – 1,400 kilometers of coral reefs and 3,300 square kilometers of mangroves, Madagascar's exceptional biodiversity is also marine. Marine biodiversity in Madagascar's Exclusive Economic Zone of over one million square kilometers is the most marine diverse in the Western Indian Ocean and one of the most diverse in the Indian Ocean (CBD, 2022; CEPF, 2014b). The country's marine waters are rich in coral species (380), reef fish (788), eight endemic species of sharks and one species of dugong. Humpback whales breed and three other species migrate through Madagascar's EEZ (Botosoamananto et al., 2021; CEPF, 2014a). Madagascar's marine waters are contained within the Agulhas Current large marine ecosystem which is characterized by warm waters (20-30 degrees Celsius) and low primary productivity, except a few small areas of

122. An endemic species is a species native to, and restricted to, a particular geographical region (IUCN definition).
123. Madagascar separated from Gondwana about 166 million years ago and from India about 88 million years ago.
124. Ganzhorn et al., 2014.

upwelling (CEPF, 2014a). This marine ecosystem supports the country's marine biodiversity as it contains the majority of coral reefs in the Western Indian Ocean. Madagascar's proximity to continental Africa protects its west coast resulting in two marine ecoregions: Western and Northern Madagascar — the marine biodiversity hotspot — and Southeast Madagascar, where exposed coastline limits biodiversity.

103. **Madagascar's biodiversity and ecosystems are of global importance, but they especially make a major contribution to domestic economic growth, resilience, and jobs, including from tourism.** As Chapter 2 illustrated, Madagascar's forests, where the majority of protected areas and greatest biodiversity are located, also play a key role in broader watershed protection and flood management, including in prevention of erosion. They also help to maintain water flows for hydro-electric power generation, fresh water, and irrigated agriculture. Two national parks, for example —Montagne d'Ambre and Ranomafana — provide hydropower and drinking water to Antsiranana, Fianarantsoa, Ambalavao and Mananjary (a total population of 400,000). Marine biodiversity in Madagascar's one million km^2 EEZ is the richest in the West Indian Ocean. Its mangroves, shorelines and coral reefs help protect coastal areas against storm surges from typhoons and other extreme weather events and are important spawning grounds for a wide range of fish species. Madagascar has been classified one of the world's highest conservation priorities,[125] with protected areas being the principal tool used for the conservation of biodiversity. Sustainably managed tourism in protected areas can also make a major contribution to economic development, as well as to the continued conservation of the protected areas themselves.

104. **Nature-based tourism plays an important role in Madagascar's economy.** Globally, protected areas receive eight billion visits a year[126] and before the COVID-19 pandemic, tourism, including in protected areas, was a rapidly growing economic sector, providing one in 10 jobs globally.[127] As indicated in Chapter 1, in 2019 Madagascar's tourism sector, the vast majority of which is nature-based, contributed 12.7 percent[128] of GDP and 9.9 percent of employment (including both its direct and indirect contribution). A 2012 visitor survey[129] indicated that 64 percent of visitors to Madagascar visit at least one national park, although just six national parks (out of 123 protected area sites) account for 83 percent of visits. Madagascar's tourism products leverage the country's astounding biodiversity, landscapes and unique culture. Tourism provides jobs to communities living near protected areas, either directly (e.g., guides, drivers, hotel and restaurant staff) or indirectly (e.g., food and services to the hotels and restaurants). Tourism is a significant contributor to local, regional, and national value chains (e.g., hospitality, travel agencies, handicraft, agriculture), as well as to park fees, tax revenues, foreign currency, and foreign direct investment. Furthermore, it ranks well in terms of female participation in the tourism labor market (11th out of 136). Marine and coastal tourism is important, with 63 percent of tourists surveyed reporting spending time at a beach, although such visitation is concentrated in four main areas (Nosy Be, Antsiranana, Sainte Marie Island, and Toliara). Given its pristine beaches, islands, and coral reefs, the country has a comparative advantage in the region for the development of high-value luxury marine and nautical tourism development in addition to its traditional nature-based, terrestrial products.[130] In addition, Madagascar's tourism attractions are spread throughout the island and extend beyond urban areas into some of the highest poverty regions.

105. **Tourists come to Madagascar for leisure, stay longer and spend more than in comparable destinations.** Madagascar's yield (average

125. USAID, 2022. Madagascar Environment and Climate Change. Available at: https://www.usaid.gov/madagascar/environment#:~:text=Madagascar%20is%20one%20of%20the,culturally%2C%20and%20economically%20valuable%20resources

126. Balmford, Andrew, Jonathan M. H. Green, Michael Anderson, James Beresford, Charles Huang, Robin Naidoo, Matt Walpole, and Andrea Manica, 2015. Walk on the Wild Side: Estimating the Global Magnitude of Visits to Protected Areas. PLOS Biology 13 (2):e1002074. https://doi.org/10.1371/journal.pbio.1002074.

127. WTTC, 2019. Travel and Tourism Performance, 2019. Available at: https://wttc.org/Research/Economic-Impact

128. WTTC: Madagascar. Research Highlights 2021. Available at: https://wttc.org/Research/Economic-Impact/moduleId/704/itemId/153/controller/DownloadRequest/action/QuickDownload. Updated from IFC: Creating Markets in Madagascar. Private Sector Diagnostic, 2021. Available at: https://wbgeconsult2.worldbank.org/wbgect/download?uuid=31e955b4-7aae-4b2c-9685-c3bdb613e044

129. World Bank, 2013. MADAGASCAR Tourism Sector Review: Unlocking the Tourism Potential of an Unpolished Gem. Washington, DC: World Bank Group. Available at: https://openknowledge.worldbank.org/handle/10986/16709

130. IFC, 2021. Creating Markets in Madagascar. Country Private Sector Diagnostic. Washington, DC: World Bank Group. Available at: https://www.ifc.org/wps/wcm/connect/publications_ext_content/ifc_external_publication_site/publications_listing_page/cpsd-madagascar

spent per visitor) in 2010 to 2017 was by far the highest among six comparative countries,[131] with US$2,626 earned per tourist in 2017. In addition, prior to the COVID-19 pandemic, the country enjoyed a high average length of stay (15 days) and high return visitor rates (40 percent) among leisure tourists. Visitors are mainly European leisure tourists and key markets are those with historical links to Madagascar. France is historically the largest source market by far, making up 24 percent of international arrivals in 2018. Other key markets are Italy (15 percent), particularly for the northern island destination of Nosy Be, and the United States (two percent). The number of visitors has declined sharply as a result of the COVID-19 pandemic, but tourism has the potential to play a major role in the post COVID-19 recovery. The challenge is to ensure that, moving forward, tourism is inclusive and sustainable, and that it contributes to economic growth while conserving biodiversity.

106. **Madagascar's ecosystems have deteriorated over the last five decades and their health and resilience are under threat.** Most protected areas, and most of Madagascar's endemic flora and fauna, are found exclusively in forests, which are shrinking and increasingly fragmented. Thus, forest loss and threats to the integrity of protected areas – and their ability to generate tourism revenues – are closely linked. This deterioration has been largely due to increased pressure on the land from population growth,[132] combined with poverty-driven, low productivity subsistence agriculture based on shifting cultivation, livestock rearing, firewood collection and charcoal production, as well on the logging of precious woods, cash crop cultivation, artisanal mining, and hunting.[133]

107. **Marine and coastal ecosystem health has, similarly, been damaged by poor management and unsustainable practices.** Marine resources are over-fished by both small-scale fisheries and mostly offshore industrial fisheries, where weak governance with limited monitoring control and surveillance has resulted in illegal fishing. Moreover, licenses are issued to foreign vessels with little understanding of the stock status for specific species.[134] Habitat degradation, including loss of seagrass[135] and loss of coastal mangroves through logging and poorly managed development,[136] has also contributed to declining catches. Madagascar's coral reefs have also shown a relatively rapid and significant decline in coral cover from 50 percent to 30 percent in the last 20 years, losing 20 percent of cover, or around one percent per year, driven by destructive fishing practices, pollution, sedimentation from land-based activities and climate change. Ecosystem deterioration is of concern not only because of the loss of globally significant species found in no other country, but also because of the loss of the regulating and protection services that intact ecosystems provide (e.g., climate resilience), as well as the loss of assets which play a key role in Madagascar's economy (e.g., ensuring livelihoods for rural populations).

EVOLUTION AND MANAGEMENT OF MADAGASCAR'S PROTECTED AREA SYSTEM

108. **Madagascar's protected area management has expanded rapidly over recent decades.** Its first national parks were created in 1927, and by the mid-1980s, the network included 36 protected areas whose main focuses were conservation and research. In 1991, with the assistance of the World Bank, Madagascar launched Africa's first National Environmental Action Plan (NEAP), whose objective was to "reconcile the population with its environment to achieve sustainable development," conserve the country's critical biodiversity, and by doing so, improve the livelihoods of local communities dependent on natural resources. This was followed by an ambitious, multi-donor program of support which provided considerable external financing to the conservation of biodiversity. By 2003, the protected

131. Kenya, Madagascar, Mauritius, Seychelles, Sri Lanka, and Tanzania.

132. WDI, 2022. Madagascar's population was 4.1 million in 1950, compared with nearly 28 million in 2022.

133. IFC, 2021. Creating Markets in Madagascar: Country Private Sector Diagnostic. Washington, DC: World Bank Group. Available at: https://www.ifc.org/wps/wcm/connect/publications_ext_content/ifc_external_publication_site/publications_listing_page/cpsd-madagascar

134. WAVES, 2013. The Global Partnership on Wealth Accounting and the Valuation of Ecosystem Services. Washington DC, World Bank Group. Available at: https://www.wavespartnership.org/sites/waves/files/images/WAVES-Annual-Report-2013.pdf

135. Sieglind Wallner-Hahn, Malin Dahlgren, and Maricela de la Torre-Castro, 2022. Linking Seagrass Ecosystem Services to Food Security: The Example of Southwestern Madagascar's Small-scale Fisheries. Available at: https://www.researchgate.net/publication/356541216_Linking_seagrass_ecosystem_services_to_food_security_The_example_of_southwestern_Madagascar's_small-scale_fisheries

136. Vyawahare, Malavika, 2020. "An Export Boom Threatens to Put Madagascar's Mud Crabs in Hot Water." Mongabay Series. Available at: https://news.mongabay.com/2020/07/an-export-boom-threatens-to-put-madagascars-mud-crabs-in-hot-water/

area network had expanded to 46 sites covering 1.7 million ha and has since grown to include 123 sites covering 7.1 million ha, or 12 percent of the national territory. Since most of these are in forests, and natural forests cover 14 percent of the country, approximately half of the natural forest area is now under protected area management.

109. **Marine protected areas emerged more recently but have also expanded rapidly.** With 5,600 kilometers of coast – the longest in Africa – 1,400 kilometers of coral reefs and 3,300 square kilometers of mangroves, Madagascar's marine biodiversity is exceptional. Marine conservation was limited to a handful of marine protected areas and some promising experiences of Locally Managed Marine Areas (LMMAs) until the 2003 Durban Vision, after which the network expanded rapidly, driving an expansion in marine conservation efforts. As of 2022, NGO-supported initiatives have helped expand marine protected areas — including LMMAs, 22 protected areas covering 1.25 percent of Madagascar's EEZ, and 0.8 million ha, with one percent under full protection — while LMMAs covered 18 percent of the coastline.[137, 138, 139, 140] Many of these rely on community-based fisheries management that targets the recovery of fast-growing species to help fishing-dependent communities derive meaningful livelihood benefits from resource management while avoiding resource depletion and habitat destruction. In some communities, these efforts are restoring stocks and marine biodiversity.

110. **The NEAP helped transform environmental management in Madagascar.** By 2015, a series of three World Bank-led investment projects in support of the NEAP had disbursed US$450 million from several donors.[141,142,143] Key national institutions for environmental management were created, such as the National Environment Office *(Office National pour l'Environnement,* ONE) and the National Agency for Protected Area Management (Association National pour la Gestion des Aires Protégées, ANGAP, now Madagascar National Parks, MNP), in charge of the management of all protected areas. ANGAP (MNP) was created as a parastatal organization, outside the direct control of the government, and took over the management of protected areas from the ministry responsible for the environment. The NEAP also supported the national law requiring environmental impact assessment and impact mitigation for new developments, and legal frameworks allowing co-management of natural resources with local communities.

111. **In parallel, new objectives were laid out for the protected areas network involving shared governance approaches.** Management approaches to the new protected areas have increasingly followed the "Durban Vision" laid out during the Fifth World National Parks Congress in 2003,[144] which aspires to make local populations the partners and beneficiaries of conservation. Access to protected areas existing before 2003 was restricted to biodiversity conservation, research, and recreational purposes (IUCN categories I and II). Almost half of the country's protected areas are now gazetted under IUCN categories III through VII, categories that permit sustainable extractive use of natural resources according to a zoning plan (e.g., livestock grazing, fuelwood collection, charcoal production, commercial artisanal fishing, and the harvest of wood, non-timber, and marine products). The principle of shared governance was articulated in recent strategies, including the 2014 MNP Strategic Plan, and subsequent legislation, including the 2015 Protected Area Code[145] and its subsequent implementing decrees. (See Box 4.1 below).

137. Marine Conservation Institute, 2022. Marine Protection Atlas. Available at: https://mpatlas.org/countries/MDG

138. TL Mayol, 2013. Madagascar's Nascent Locally Managed Marine Area Network. Madagascar Conservation & Development 8 (2): 91–95. Available at: https://doi.org/10.4314/mcd.v8i2.8

139. MIHARI, 2015. The First Wave of Community-Managed Marine Protected Areas in Madagascar. Available at: https://mihari-network.org/en/news/the-first-wave-of-community-managed-marine-protected-areas-in-madagascar/

140. MIHARI, 2022. LMMA IN MADAGASCAR. Available at: https://mihari-network.org/base-de-donnees/lmma-a-madagascar/

141. Gardner, C.J., Nicoll, M.E., Birkinshaw, C., Harris, A., Lewis, R.E., Rakotomalala, D., Ratsifandrihamanana, A.N, 2018. "The rapid expansion of Madagascar's protected area system." Biological Conservation, 220:29-36.

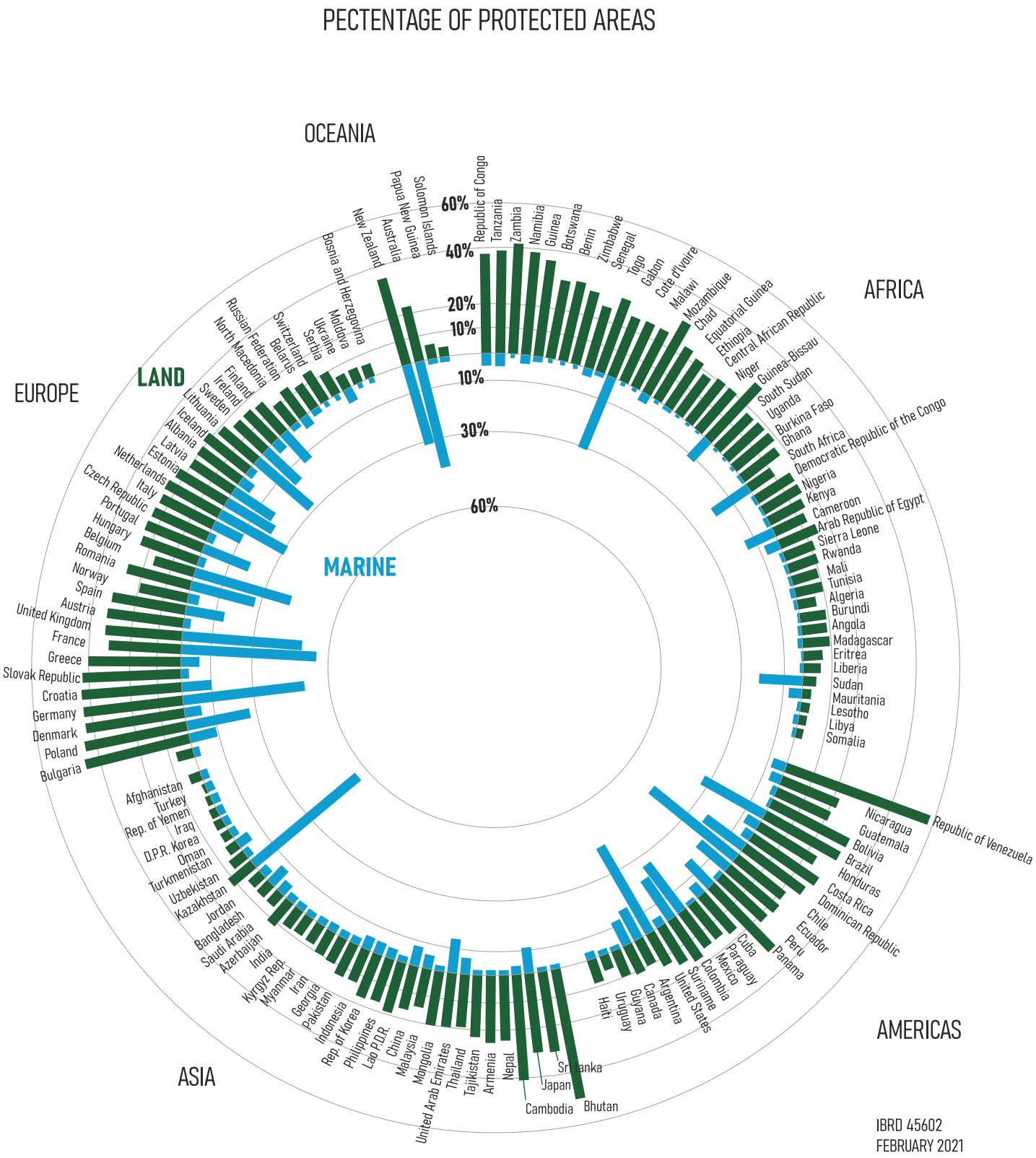
142. Jones, J.P.G., Rakotonarivo, O.S., Razafimanahaka, J.H, 2021. Forest Conservation in Madagascar: Past, Present, and Future. In S. M. Goodman (Ed.), The New Natural History of Madagascar. Princeton University Press.

143. World Bank, 2021. Madagascar—Third Environment Program Support Project. Independent Evaluation Group, Project Performance Assessment Report. Washington, DC: World Bank.

144. IUCN, 2005. Benefits beyond boundaries: proceedings of the Vth IUCN World Parks Congress. Available at: https://portals.iucn.org/library/node/8662 UNEP, 2015. Loi n° 2015-005 du 26 février 2015 portant refonte du Code de Gestion des Aires Protégées. Available at: http://faolex.fao.org/docs/pdf/mad146122.pdf

145. UNEP, 2015. Loi n° 2015-005 du 26 février 2015 portant refonte du Code de Gestion des Aires Protégées. Available at: http://faolex.fao.org/docs/pdf/mad146122.pdf

Figure 4.1. Terrestrial and Marine Protected Area Percentages Per Country



Source: Adapted from Maxwell et al. (2020), using data from UNEP-WCMC and IUCN 2020.

Note: The figure is showing the increase in area coverage (%) per year for marine and terrestrial protected-are estates for countries >25,000 km^2.

Table 4.1. Terrestrial Protected Areas and Marine Protected Areas in Madagascar and Peer Countries

Country	Terrestrial Protected Areas		Marine Protected Areas	
	Land area covered / Total land area	% coverage	Marine and coastal area covered / Total marine and coastal area	% coverage
Madagascar	62,333.17 km² / 594,719 km²	10.6%	13,800 km² / 1.14 million km²	1.1%
Bangladesh	6,456 km² / 140,160 km²	4.61%	4,540 km² / 84,563 km²	5.36%
Cambodia	72,527 km² / 182,511 km²	39.14%	691 km² / 47,967 km²	1.44%
Rwanda	2,317 km² / 25,452 km²	9.11%	0 km² / 0 km²	0%
Tanzania	363,541 km² / 947,253 km²	38.38%	7,330 km² / 243,130 km²	3.02%
Uganda	39,054 km² / 243.145 km²	16.06%	0 km² / 0 km²	0%

Source: IUCN, UNEP-WCMC, 2021. The World Database on Protected Areas (WDPA). Cambridge (UK): UNEP World Conservation Monitoring Centre. Available at: www.protectedplanet.net

Box 4.1. The Protected Area Code (Codes des Aires Protégées, COAP) 2015

The 2003 Durban Vision of tripling the country's terrestrial protected area network within five years required the creation of new protected areas in addition to expanding the existing ones. This was unlikely to be achieved within the narrow definition of protected areas provided by the first Protected Area Code (COAP) of 2001. In addition, many non-governmental organizations were already involved in the sustainable management of areas of forests to help reduce deforestation, and called for a broadening of the scope of protected areas in Madagascar.

After a lengthy process involving extensive consultations and negotiations under the guidance of a dedicated national commission, a new COAP was prepared to provide the tools to achieve this vision. The preparation was delayed by the political turmoil following the 2009 coup, and it was finalized and approved in 2015 (Loi n°2015-005 portant refonte du Code de Gestion des Aires Protégées). The revised COAP is inspired by the principles developed by the International Union for the Conservation of Nature (IUCN), including allowing a modern management of protected areas, opening the management of protected areas to new actors and methods, and building natural capital and promoting the sustainable use of natural resources for poverty reduction.

The revised COAP allows the creation of three new types of protected areas (Natural Monument (IUCN type III), Protected Harmonious Landscape (IUCN type V), and Natural Resource Reserve (IUCN type VI)), enabling Madagascar protected areas to follow all types defined by the IUCN. In addition, the COAP integrates the four IUCN governance types, giving them all equal legitimacy within the national system: governance by government; shared governance; governance by private individuals and organizations; and governance by local communities.

The revised COAP was completed in 2017 by an implementing decree establishing the procedure for the creation, modification, and management of protected areas *(Décret N°2017-415 du 30 mai 2017 fixant les modalités et les conditions d'application de la Loi n° 2015-005).*

112. **New protected areas have typically been established with shared governance arrangements.**[146] A promoter, usually an international or Malagasy NGO,[147] promotes and manages the protected area, generally under a co-management agreement with regional authorities, local communities, and private sector representatives (e.g., tourism operators).[148] The first step involves an application for temporary protection, and the second the application to gain definitive protection. This includes documents describing the management of land-use conflicts, public consultations, the delimitation and securing of land, an approved management plan, and an environmental and social management plan.[149] All new protected areas now name the promoter as delegated manager with obligations *("cahier de charge")* defined by the state as part of the management delegation. In the long term, the Government of Madagascar aims for promoters to withdraw into more advisory roles, although this will imply that there is a system ready to continue management. MNP also seeks to establish management partnerships with specialist institutions for the expansion and professionalization of key services (e.g., tourism infrastructure provision, applied research, and small scale private sector enterprise development).

113. **Marine conservation initiatives in Madagascar only began in earnest after 2003 but shared governance arrangements are now widely used.** Despite some progress and the Government of Madagascar's commitment to triple its marine protected areas in 2014 (IISD, 2014), there are currently 22 MPAs covering 13800 km2 or 11.8% of continental shelf. A national association helps to lesson sharing and lobbying for legal recognition of LMMAs while[150] specific projects or programs focus on establishing marine protected areas, LMMAs[151] and fisheries, and on selected species. As of 2022, MNP manages 43 protected areas (1.5 million hectares), while 67 protected areas (four million hectares), called the New Protected Areas,[152] are managed by non-state actors. Together with less protected marine areas, national parks with a marine component and LMMAs, the total share of Madagascar's waters under some form of protection reaches 1.25 percent. The 178 LMMAs spanning 18 percent of Madagascar's coastline (MIHARI, 2022), which can have multiple uses including extractive activities, have had varying degrees of success in meeting their management objectives that are often fisheries related (Mayol, 2013). Many new marine protected areas rely on community-based management, targeting the recovery of fast-growing species to help fishing-dependent communities derive meaningful livelihood benefits from resource management while avoiding resource depletion and habitat destruction.

114. **As noted, Madagascar was one of the first countries in Africa to formalize community-based natural resource management, and this also applies to buffer zones adjacent to protected areas.** Communities adjacent to protected areas may integrate into a Protected Area Orientation and Support Committee *(Comité d'Orientation et de Soutien à l'Aire Protégée,* COSAP) and form a Local Park Committee *(Comité Local du Parc,* CLP) whose main task is the surveillance of their adjacent park sector. CLPs also help prioritize development interventions and submit their proposals to the COSAP for approval and funding.

115. **GELOSE and GCF have been widely used, especially to create the buffer zones around protected areas.** As mentioned, in 1996 Madagascar adopted the law on Secure Local Management *(Gestion Locale Sécurisée,* GELOSE) and in 2001 adapted this to forest management

146. UNEP, 2015. Article 33 of the 2017 Implementation Decree of the 2015 Protected Area Code (« Décret N°2017-415 du 30 mai 2017 fixant les modalités et les conditions d'application de la Loi n° 2015-005 du 26 février 2015 portant refonte du Code de Gestion des Aires Protégées ») Available at: http://faolex.fao.org/docs/pdf/mad146122.pdf

147. Promoters also include universities, mining companies as part of their biodiversity strategy, and private individuals. Participating NGOs include Conservation International, World Wildlife Fund, World Conservation Society, the McArthur Foundation and Blue Ventures, among others, often in collaboration with local NGOs and community production associations. Two neighboring protected areas are managed by a private mining company, Qit Madagascar Minerals (a subsidiary of Rio Tinto).

148. Franks, P., Booker, F, 2015. Shared Governance of Protected Areas in Africa: Case Studies, Lessons Learnt and Conditions of Success. IIED, London.

149. UNEP, 2017. 2017 Implementation Decree of the 2015 Protected Area Code (« Décret N°2017-415 du 30 mai 2017 fixant les modalités et les conditions d'application de la Loi n° 2015-005 du 26 février 2015 portant refonte du Code de Gestion des Aires Protégées ») Available at: http://faolex.fao.org/docs/pdf/mad203129.pdf

150. MIHARI, 2018. LMMA A MADAGASCAR. Available at: https://mihari-network.org/base-de-donnees/lmma-a-madagascar/

151. Vogel et al., 2019. LMMAs are marine and/or coastal areas managed by one or more communities to help protect fisheries resources and marine biodiversity. The first LMMA in Madagascar was created in 2005.

152. In addition, 13 parks covering 0.5 million ha have been created but abandoned by their manager (MNP or promoter) and fall under the authority of the Ministry of the Environment. They are not managed and are considered paper parks.

through Contractualized Forest Management *(Gestion Contractualisée des Forêts,* GCF). These contracts cover five percent of the Malagasy territory and 30 percent of the current forests, including 20 percent within protected areas (around core conservation areas). The LMMA is considered part of the GELOSE legal framework (community management) but has limited legal standing, with *dina* rules ,[153, 154] often used to restrict access or catches. Although Madagascar's National Parks legally recognizes community-based management as a form of governance, LMMAs are not part of this system (USAID, 2019; Rakotondrazafy, 2014), yet they could be an intermediate step towards establishing formal MPAs.

LEARNING FROM PAST EXPERIENCE: CHALLENGES IN BIODIVERSITY CONSERVATION

116. **Thirty years of expansion of community-based natural resource management have not slowed deforestation or biodiversity loss as much as anticipated.**[155,156,157,158] The country has lost close to 20 percent of its forest cover since 1990. The objective of improving both biodiversity conservation and human well-being has had limited success. There is no determinate evidence that protected areas managed by NGOs are more effective in relation to conservation or tourism objectives than those managed by MNP. Although the shift to shared governance and co-management should in principle result in more effective improvement of human well-being, this has not yet substantially materialized systematically. VOIs have had limited capacity to implement GCF (management contracts) and *dina* rules further limit their authority: there have been issues with migrants moving in from other areas, distrust between stakeholders, and issues with the effectiveness of power transfer.[159]

117. **In coastal and marine areas, the LMMA model has also had modest outcomes to date.** Lack of a strong legal basis for the LMMAs limits effectiveness within the GELOSE framework. Community success in enforcing the *dina* rules, managing outside fishers and migrants accessing the resource, ensuring understanding within the community of appropriate management measures, and accessing financing are key elements in improving biodiversity outcomes and human well-being.[160,161]

118. **Improvement to the economic well-being of communities dependent on forests and coastal and marine resources has not met expectations and this failure may have contributed to the limited results in halting degradation.** The root causes of deforestation relate to low (and declining) soil productivity in agricultural lands and continued incentives to practice slash-and-burn agriculture (tavy). Land tenure issues, labor constraints, poverty and illiteracy, inadequate access to modern forms of energy, limited transport and irrigation infrastructure, constrained markets, weak

153. Vogel et al., 2017. Available at: https://www.researchgate.net/publication/297962919_Using_the_dina_tool_as_governance_of_natural_resources_lessons_of_Velondriake_southwestern_Madagascar

154. In order to reduce conflict between national laws and local customs and social norms (known as dina), the Government of Madagascar has progressively decentralized the governance of natural resources to local levels. Rules regarding resource use within contractual management transfers and co-managed protected areas are defined within dina, which can be legally recognized. The 'dina', which can be translated as social pact, is a customary institution defined as a traditional local convention used to establish common rules for the purpose of social cohesion, mutual aid or security, and which includes sanctions for non-compliance.

155. Desbureaux, S., Aubert, S., Brimont, L., Karsenty, A., Lohanivo, A.C., Rakotondrabe, M., Razafindraibe, A.H., Razafiarijaona, J, 2016. "The Impact of Protected Areas on Deforestation: An Exploration of the Economic and Political Channels for Madagascar's Rainforests (2001–12)." Etudes et Documents, n°3, CERDI.

156. Desbureaux, S., Damania, R, 2018. "Rain, forests and farmers: Evidence of drought induced deforestation in Madagascar and its consequences for biodiversity conservation." Biological Conservation, 221:357-364.

157. Eklund, J., Coad, L., Geldmann, J., and Cabeza, M, 2019. "What Constitutes a Useful Measure of Protected Area Effectiveness? A Case Study of Management Inputs and Protected Area Impacts in Madagascar." Conservation Science and Practice, 1 (10).

158. These assessments have mostly focused on the historical protected areas, those managed by MNP for which long-term data exists. There is no consensus among stakeholders (including promoters of new protected areas) that new protected areas do or do not perform better. One of the promises of management transfers is that communities will improve their livelihoods by directly receiving the benefits of well managed natural resources on which they rely (e.g., food, firewood, building materials, and traditional medicines). Estimates of the impact of community forest management on household living standards as measured by per capita consumption expenditures, find that impacts are positive, but small and not statistically different from zero. However, when effectiveness is measured by deforestation rates studies show that rates are lower within protected areas than outside (Eklund 2016 Eklund et al., 2016. Contrasting spatial and temporal trends of protected area effectiveness in mitigating deforestation in Madagascar. J. Eklund, … +4 …, M. Cabeza. Biol. Conserv., 203 (2016), pp. 290-297, 10.1016/j.biocon.2016.09.033..

159. Jones, J.P.G., Rakotonarivo, O.S., Razafimanahaka, J.H, 2021. Forest Conservation in Madagascar: Past, Present, and Future. In S. M. Goodman (Ed.), The New Natural History of Madagascar. Princeton University Press.

160. Ratsimbazafy, Hajaniaina, Thierry Lavitra, Marc Kochzius, and Jean Hugé, 2019. "Emergence and Diversity of Marine Protected Areas in Madagascar." Marine Policy 105 (July): 91–108. https://doi.org/10.1016/j.marpol.2019.03.008.

161. USAID, 2019. "MADAGASCAR FAA 118/119 BIODIVERSITY AND TROPICAL FORESTRY ANALYSIS." Madagascar: USAID.

governance and political instability all reduce the ability of conservation projects to transform local farming systems and manage natural resources sustainably. In marine and coastal areas, the combination of the failure of other sectors, weak governance of coastal and fisheries resources, migration, habitat destruction, and climate change are driving marine resource degradation. Increasing demand for seafood and weak fisheries governance creates opportunities for corruption and illegal, unreported and unregulated (IUU) fishing which exacerbates overfishing. Habitat destruction, especially of coastal fish nursery areas such as mangroves, coral reefs, and seagrass and the increasing impacts of climate change further add to the challenges.[162] The landscape approach recently developed by the Government of Madagascar with the support of the World Bank aims to reconcile rural development and biodiversity conservation and can be applied to the management of coastal zone and marine areas (an approach recognized elsewhere as seascapes) as well as to terrestrial areas (ridge to reef).

119. **Shared management of marine areas and resources is also a challenge.** There are four possible forms of shared governance and management within LMMAs: *dina*, transfer management of natural resources, transfer management of aquatic resources and MPAs.[163,164] Most LMMAs are managed through *dina* rules, with the rules primarily for managing fish resources. These LMMAs face many challenges, with rule enforcement and corruption often cited. There are no LMMAs where management of aquatic resources has been transferred because it requires a fisheries management plan and there are none developed for any LMMA to date. Velondriake, the first LMMA established in 2006, was gazetted as an MPA in 2015 along with four other LMMAs. However, they require considerable resources from NGOs. Despite the potential for the LMMA model to be used for biodiversity conservation and marine resource management, the current legal and regulatory frameworks such as GELOSE may need to be reviewed to realize the potential of LMMAs.

FINANCING OF PROTECTED AREA MANAGEMENT

120. **The protected area network is generally under-funded.** The network currently receives no direct funding from the central government budget. Total available funding is estimated at US$6 to 8 million[165] annually for MNP compared with estimated requirements of US$25 to 35 million for the entire protected area system of Madagascar's size.

    (i) *Madagascar Biodiversity Trust Fund (Fondation pour les Aires Protégées et la Biodiversité de Madagascar,* FAPBM). In 2005, after the Durban Vision, Madagascar created the FAPBM, an endowment fund aimed eventually at financing the operating costs of the entire system of protected areas. FAPBM has an endowment of US$138 million as of January 2022 and although this is insufficient to meet all financing requirements it is considered a major success of the biodiversity conservation system in Madagascar and a model of conservation trust funds for other countries. Its governance complies with standards of practice developed by the Conservation Finance Alliance and it is achieving its financial performance objectives. It provided significant resources to the management of protected areas,[167] even during the 2020 to 2021 COVID-19 crisis, and it catalyzes new and additional financing.[168] It contributed US$2.31 million to the protected area network in 2021

162. Wallner-Hahn, Sieglind, Malin Dahlgren, and Maricela de la Torre-Castro, 2022. "Linking Seagrass Ecosystem Services to Food Security: The Example of Southwestern Madagascar's Small-Scale Fisheries." Ecosystem Services 53 (February): 101381. Available at: https://doi.org/10.1016/j.ecoser.2021.101381

163. MIHARI, 2015. "The First Wave of Community-Managed Marine Protected Areas in Madagascar." Available at: https://mihari-network.org/en/news/the-first-wave-of-community-managed-marine-protected-areas-in-madagascar/

164. MIHARI, 2022. "LMMA IN MADAGASCAR." Available at: https://mihari-network.org/base-de-donnees/lmma-a-madagascar/

165. MNP, 2021. Notre Défi pour les Années 2021 et 2022.

166. Estimates of 'ideal' protected area management costs for Madagascar's protected areas vary significantly and an average figure is US$10 per ha per annum (used by FAPBM). The MNP network covers 1.5 million ha, and its 'ideal' budget using this figure is in the order of magnitude of US$25 million.

167. The main contributors to the endowment fund are: KfW (39%), French government (17%), AFD (12%), GEF (11%), Conservation International (9%), and World Bank (9%).

168. Republique Francaise, 2021. Assessment of Conservation Trust Funds: for the Benefit of Biodiversity. Available at: https://www.afd.fr/en/actualites/assessment-conservation-trust-funds-benefit-biodiversity

and it partially supported 36 PAs[169,170] in 2020 and 2021 (covering close to 30 percent of their budget), and plans to support 45 in 2022.[171]

(ii) *Tourism* generated US$2 million annually before the pandemic in direct revenues, US$1.5 million from entry fees and U$0.5 million from other tourism revenues. One challenge is that at present 83 percent of tourists visit only six protected areas. Expansion is constrained by a number of factors (see next section). Revenues are pooled and shared with other protected areas.

(iii) *Donors* (development finance institutions, international NGOs, and foundations) finance the remaining US$2 to four million annually. There is no aggregated data for new protected areas, for which financing varies considerably but is perhaps even more volatile. VOIs have limited management capacity and technical and financial resources, and depend highly on the financial and technical resources of external partners (NGOs, donors) for the elaboration and implementation of management plans[172] and for the financing of 3-year and 10-year evaluations that are critical to their renewal. This dependency questions the actual autonomy of communities in managing their resources in a context where donor funding and NGO support are time-bound.

121. **While external funding is critical to the financing of the protected area network, these funding sources are unreliable in the long-term.** Donor priorities can change and timescales are often short, periodic political crises have resulted in international sanctions and donor withdrawals, and events such as the COVID-19 pandemic and cyclones, as well as political instability can severely impact tourism revenue. The FABM remains a predictable source of revenue and given its governance success there is scope for expanding the endowment. In the longer run there is also scope for direct funding of protected areas by the Madagascar government (as is the situation in most countries) if their public good benefits can be clearly demonstrated.

122. **Benefit sharing with local communities may advance development and conservation goals but the current scope is limited.** Benefit sharing can include direct sharing of fees and other charges, indirect benefits from employment generation, and public-private partnerships connected with tourism in protected areas. The current legal framework as set out in the 2017 *Code sur les aires protégées* (COAP) provides for flexible benefit sharing of up to 50 percent of tourist entry fees with local communities, based on presentation of eligible development projects. However, in practice tourism revenues are distributed throughout the protected area system to help finance management costs, including those of the protected areas that do not receive significant numbers of tourists. If half of the US$1.5 million of entry fees collected every year were shared among the many communities surrounding the protected area system in its entirety, the revenue per community would be very modest. Alternative forms of benefit sharing are taking place, but their impact is not assessed. The bulk of the direct benefits shared from protected areas appears to be the provision of employment (e.g., local guides, porters, canoe drivers, and construction workers for tourist infrastructure). MNP does finance community development projects in the framework of donor-funded projects. Detailed information about these different benefit sharing mechanisms, their amount, their beneficiaries, and their impact is not readily available.

TOURISM IN PROTECTED AREAS: CHALLENGES AND POTENTIAL

123. **Promotion of tourism has been a cornerstone of Madagascar's protected areas and biodiversity strategy since the 1990s but visitors are concentrated in only a few parks.** Between 2017 and 2019, an annual average of 210,000 tourists[173]

169. 22 MNP protected areas (44 percent of all MNP protected areas) and 14 non-MNP protected areas (19 percent of all non-MNP protected areas) received partial funding. For non-MNP protected areas: FAPBM contributed to 29 percent of the financial needs; most funds were used for conservation activities (40 percent on patrolling, boundary delimitation, and ecological surveys) and recurring costs (42 percent on salaries and operating costs of the NGOs). For MNP protected areas: FAPBM contributed to 28 percent of the financial needs; funds were used to cover payroll expenses and some operating costs; many MNP protected areas did not receive sufficient funding to implement all of the 2019 annual work plan.

170. World Bank, 2021. FAPBM Annual Report 2019.

171. FAPBM, 2022. 45 AIRES PROTÉGÉES BÉNÉFICIERONT DES FINANCEMENTS DE LA FAPBM POUR L'ANNÉE 2022. Available at: https://www.fapbm.org/45-aires-protegees-beneficieront-des-financements-de-la-fapbm-pour-lannee-2022/

172. VOIs' financial resources are limited to membership fees, harvest authorizations and fines actually paid by offenders, which rarely represent more than a hundred US dollars per year.

173. Including 35 percent of Malagasy nationals.

visited protected areas managed by MNP, generating Ar6.9 billion (US$2 million) of direct annual revenues for MNP or 25 percent of total funding.[174] Visits and revenues grew steadily after the 2009 to 2014 political crisis, but had still not rebounded to their 2019 peak when the COVID-19 pandemic hit, and numbers declined sharply. There is no consolidated tourism data for new protected areas, which for the most part do not attract large numbers of tourists. Tourism is highly concentrated in a minority of protected areas, with six national parks (five percent of the number and coverage of protected areas) receiving 83 percent of visitors on average between 2017 to 2019: Nosy Tanikely;[175] Isalo; Andasibe and Analamazaotra; Ranomafana; Bemaraha; and Montagne d'Ambre. These are mostly in the north and east of the country.

124. **The government of Madagascar and the African Development Bank (AfDB) are currently preparing an investment in the sector.** The Climate Resilience for Biodiversity Preservation Project *(Projet de Résilience Climatique pour la Préservation de la Biodiversité,* PRCPB) is expected to have US$15 million in financing to promote ecotourism to strengthen the conservation of protected areas and support the community to cope with the effects of climate change. The project would finance infrastructure in selected protected areas,[176] capacity strengthening of MNP, promotion of ecotourism (including tourism concession), and community development. Currently in preparation, the project should be presented to the board of the AfDB in June 2022 and be launched in September 2022. There are likely to be useful lessons from the approach that this project takes. The World Bank, through its Second Integrated Growth Poles Project,[177] has also historically supported MNP in its investment promotion efforts and with capacity strengthening. The project is currently supporting development of a merchandising strategy as an additional channel of revenue for MNP.

125. **The development of nature-based tourism is hampered by some significant constraints.**[178] Some cut across the entire tourism sector while others are more specific to protected areas.

(a) Constraints to the development of the tourism sector as a whole include:

- Governance challenges: the private investment environment is difficult and unpredictable with an uneven playing field and vested interests. The 2017 WEF Travel and Tourism Competitiveness Report ranked Madagascar 126th of 136 countries in terms of business environment, with issues in property rights and the cost of construction permits, and delays in obtaining financing both from commercial banks and from development finance institutions.
- Public sector capacity constraints: The Ministry of Tourism has limited capacity to monitor developments and ensure quality, or to gather and disseminate reliable data on Madagascar's tourism performance. Sector development does not follow a coordinated master plan, hindering the strategic planning of public investments that support tourism development (e.g., hotels, infrastructure, and services, such as waste management).
- Poor air connectivity: Limited and uncompetitive air connectivity is a major constraint, despite some pre-pandemic improvements. Reliability of domestic connectivity improved with the creation of a domestic subsidiary in 2018, although flights remain infrequent and expensive. Inadequate airport infrastructure and standards prevent regional airports from reaching international certification and limit their ability to cater to multi-destination travel within the country, a key product type. High jet fuel prices resulting from a supply monopoly further constrain tourism development.
- Skills challenges: A lack of qualified labor and of high-quality, accessible hospitality training opportunities burdens the private sector and detracts from the tourist experience. In-house training raises costs. Furthermore, related skills, as in market analyses, feasibility studies, or local law firms specializing in contract negotiations, are scarce. Madagascar ranked 122nd of 136 countries for human resources and the labor market in the tourism industry in 2017.[179]

174. Ar5.1 billion (US$1.5 million) in entry fees and an additional Ar1.8 billion (US$0.5 million) in revenues from the sale of camping nights, souvenirs, film licenses, school field trips, etc.
175. Nosy Tanikely is a mostly marine national park close to Nosy Be, the main beach destination in Madagascar.
176. These protected areas will likely be Andasibe-Mantandia / Anamalazoatra; Nosy Hara; Ankarana; Lokobe; Bemaraha; and Tsimanampetsotsa.
177. Part of a Series of Projects (SOP).
178. IFC, 2021. Creating Markets in Madagascar. Country Private Sector Diagnostic. Available at: https://www.ifc.org/wps/wcm/connect/publications_ext_content/ifc_external_publication_site/publications_listing_page/cpsd-madagascar
179. WEF, 2017. The Travel and Tourism Competitiveness Report 2017.

- Seasonality: Madagascar has not yet developed tourism packages for visitors outside the traditional European summer holiday period, leading to excess capacity and low occupancy rates for much of the year.
- Crises: Recurring political, security, and health related crises have generated crashes in visitation to Madagascar and exacerbated reputational challenges.

(b) Constraints to the development of tourism in protected areas:

- Road connectivity. Most protected areas can only be accessed by road, and poor road connectivity – including a complete lack of access to some areas during the rainy season – limits the development potential and quality of some of the most popular products and circuits. Poor road connectivity also limits investor interest in more isolated protected areas.
- Tourism infrastructure. Even the protected areas that receive the highest numbers of visitors generally lack the infrastructure and services (roads, trails, interpretation, toilets, camp sites, quality hotels, and activity offerings) to provide quality tourism experiences. Somewhat linked, the lack of originality and diversity in tourist experiences (including but not limited to accommodation) among protected areas hinder the development of tourism in new protected areas. Marine protected areas also lack the necessary infrastructure to both access marine sites and to mitigate human use of fragile sites, such as coral reefs (e.g., permanent moorings or allocated mooring areas) or degradation of coastal dunes and beaches (e.g., boardwalks).
- Investment climate in protected areas. Underdeveloped sector-specific legislation and regulation hinder investment opportunities and growth in high-potential markets. Despite extensive donor support, the country continues to lack a regulatory framework for land titling and private concessions in national parks (see below), and marine spatial plans to allocate areas for tourism development and avoid conflicts with other users.
- Protected area managers. In Madagascar, protected areas were initially set up with biodiversity conservation objectives and tourism was a secondary activity with potential for generating conservation financing. Managers of protected areas (MNP and NGOs) still have a stronger orientation and skills base for conservation rather than tourism development, translating into insufficient focus on the quality of the tourism experience and the enabling environment for tourism investments.
- Protected area management planning needs to adopt a more ambitious tourism approach. Most protected area management plans include a tourism section, in line with the guidance provided by the Protected Area Code and MNP's strategic pillars. These tourism sections are however very similar from one park to the other, despite significant differences in tourism activity and potential, and are insufficiently developed: they usually lack market analysis, tourism activities are limited to the development of circuits and camping, and maps show only existing tourism infrastructures and attractions. Such plans would benefit from the inputs of tourism strategies and action plans, based on the identification of each protected area's competitive advantage, market analyses, and feedback from tourism professionals, with a view to strengthening, growing, and diversifying tourism offerings (Spenceley, 2019).
- Tourism offerings are currently limited to only a few protected areas. Six protected areas receive 83 percent of visits, concentrating both positive and negative impacts on these regions. With 117 additional protected areas in Madagascar, covering many different ecosystems and landscapes, there is ample room for diversifying the tourism offering. Such diversification requires policies, programs and investments that go beyond protected areas and is made more difficult by the different constraints listed above, especially the difficulties to reach some of these protected areas. Past experiences to promote tourism in underserved protected areas have often been unrealistic because they were not sufficiently informed by market analyses and the views of the tourism private sector. For instance, tourism in protected areas is heavily driven by the structuring of one-week or two-week tourist circuits by tour operators. Any investment outside of these circuits is unlikely to meet a demand without private sector efforts to develop and market

new circuits. The tourism potential of new protected areas therefore needs to be assessed, and priority sites identified which consider marketing potential, road access, security, biodiversity, landscape attractions, and local stakeholder interest in tourism development.

126. **Tourism in protected areas, as well as nature-based tourism more broadly, generates substantial indirect benefits, which ripple beyond the tourism sector.** Tourism creates markets for products from local economies, offering economic stimuli and development benefits which make for favorable returns on government investments in protected areas and natural assets. Tourists contribute to the economy through their spending on park fees, hotels, transport, leisure, and recreation, which creates local employment. In addition, tourists generate economic activity in the local economy by stimulating local demand for goods and services, either directly (as when tourists buy goods and services from local businesses and households) or indirectly (as when lodges pay wages to local households, or source goods from local businesses, who in turn spend this income on locally supplied goods and services). The protected area tourism data currently collected in Madagascar do not cover these broad and indirect impacts. The key tourism statistic collected by MNP is the number of visitors and revenue from entry fees and other tourism products. This gives only a very limited picture of the contribution of protected area tourism to the local and national economy. There is also no systematic tourism data collection from non-MNP protected areas. The economic effects of protected area tourism can be estimated using a variety of methods that must be tailored to the environmental and social contexts in which tourism occurs and to the objective of the evaluation.

127. **The previous prioritization exercise was undertaken in 2007 with the support of the International Finance Corporation.** Based on the national strategy, development priorities, site characteristics, market attractiveness, and protected area management capacity, it selected 11 sites organized in five clusters (see Figure 4.3 below). All except one of these is in the north and west of the country. In 2014, the EP3 project financed by the World Bank relied on the 2007 selection, selecting a subset of protected areas, and adding Lokobe (following unsolicited investor interest and its potential close to Nosy Be).[180] Under the World Bank-funded Second Integrated Growth Poles project, a new selection of sites for investments inside and outside protected areas was made, again in the northern region of DIANA and and the souther region of Atsimo-Andrefanana[181]. More recently and in preparation of a proposed AfDB investment, MNP prioritized six protected areas that are a subset of the past selections: Andasibe-Mantandia / Anamalazoatra; Nosy Hara; Ankarana; Lokobe; Bemaraha; Tsimanempetsotse. Fifteen years after the most extensive exercise, the prioritization of protected areas for tourism investments deserves an update.

128. **Tourism concessions in protected areas have the potential to promote tourism, improve local livelihoods, and support the financing of biodiversity conservation.**A concession is a lease, license, easement or permit for an operation undertaken by any party other than the protected area agency. It can include a commercial operation and/or a piece of land. A tourism concession could provide accommodation, food and beverage, recreation, education, retail, and interpretive services. Madagascar has tried to develop tourism concessions in protected areas for the past 15 years, with limited success. The Government of Madagascar and MNP benefitted from the support of the IFC (Ecotourism Investment Program 2005-2009), the World Bank (Third Environmental Program Support Project, 2004-2015), and KfW (support to Ankarafantsika in 2007-2008 and 2014-2015). A 2017 report[182] summarizes key lessons:

- A *solid, comprehensive concession framework needs to be in place before looking for investors*. The concession framework should include:
  - A strong political support
  - Adequate laws and regulations
  - Clearly defined roles and responsibilities
  - Standardized procedure manuals and supporting documents

180. Mantadia, Analamazotra, Montagne d'Ambre, Ankarana, Lokobe
181. Nosy Hara, Ankarana, Tsimanampetsotse. It should be noted, however, that although the project has invested in infrastructure and services in the destinations home to these protected areas, no investments inside these protected areas have yet been made.
182. Massyn, P.J., Rajeriarison, P., 2017. "Recherche d'investisseurs pour les aires protégées de Madagascar." International Finance Corporation.

- The parks and each investment opportunity should correspond to an *actual market segment*.
- The selected sites could be subject to an *authorization following a verification,* before they are put on the market, to make sure that they are bankable and aligned with the national concession strategy.
- The main *concession conditions should be pre-established* and clearly communicated to the candidates. These conditions should also be competitive with opportunities outside the parks, where investors benefit from longer term land rights, access rights to marine areas and a less regulated operating environment.
- Once launched, the *bidding process should be candidate-focused* and be managed efficiently.

129. The concession framework needs to be finalized before investors are sought. The regulatory framework for concessions is still in development and several key elements would need to be fixed before potential sites are put on the market:

1. *Legal framework.* The revised COAP was published in 2015 and its implementing decree *("décret d'application")* in 2017. The 2017 implementing decree is not assessed as sufficiently detailed for tourism concessions and a new specific decree is being prepared ("concessions decree").
2. *Securing land tenure and access to marine areas.* The demarcation of protected areas was not always recorded in the land registries at the time of their creation. This situation poses a threat to the solidity of investment proposals and could deter investors. It seems however that recording the protected areas would require extensive work and financing that is unlikely to happen soon, and alternatives are being sought. A ministerial order *("arrêté ministériel")* is currently being drafted to provide some form of land tenure security to investors. An idea would be to demarcate only the piece of land that would support the concession. Similar efforts need to be considered for marine space, given the lack of marine tenure, and private investments need a mechanism such as a permit to be assured of access to marine spaces especially where there may be investment (e.g., permanent mooring) in infrastructure or place-based experiences (e.g., dive sites).
3. *Ministerial authority.* In parallel, the Ministry of Environment (MEDD) and the Ministry of Land Planning (MATSF) have been disagreeing on who has the authority over dealing with investors in protected areas.[183] Since 2016, the relevant ministerial departments have been working together to solve the issue through an administrative process (the signing of a "collaboration protocol"). The turn-over of Ministers, General Secretaries, and Directors has caused the process to repeatedly start over before finalization. Both Ministers were replaced during the March 2022 government reshuffle, which is expected to further delay the process.
4. *MNP's mandate.* There is a lack of clarity on the legal mandate of MNP to manage its protected areas. This mandate was previously granted by a decree under the previous Protected Area Code, but the 2015 revision of the Code was not translated into the signing of a new management delegation contract with MNP. MNP is de facto continuing to manage its protected areas under an automatic renewal assumption, seemingly acknowledged by a communication between MEDD and MNP. This situation is a potential threat to investors signing a concession contract with MNP, whose own management rights are not guaranteed.
5. *Standard contract for concessions.* Madagascar is now preparing standard concession contracts. The past projects all have prepared their own standard concession contracts. Ideally, a standard contract should be discussed with potential investors and adopted before the concessions decree to avoid contradictions.
6. *National concession strategy.* The only document guiding the development of concessions in the protected areas of Madagascar is a 2008 Policy Letter. An up-

183. MATSF argues that like for any other piece of land that is the property of the State (Domaine public de l'Etat), it (MATSF) should be the only interlocutor for any investor and that the investor should go through the standard procedure and pay its fee to its Land Services General Directorate (DGSF). MEDD argues that protected areas fall under a special regime, provided for by the different protected areas laws and regulations, that makes them (MEDD) and the protected area managers the sole interlocutors and fee recipients for concession processes within a protected area.

to-date national concession strategy would allow agreement on a vision, set objectives for concessions in terms of financial contribution (to the management of the protected area network and community development, etc.), and present the main aspects of the business plan (what kind of investment in each protected area, marketing timeline, etc.).

130. **The COVID-19 pandemic since 2020 hit the tourism sector especially hard.** Global travel restrictions and Madagascar's lengthy border closures have had particularly dramatic effects on the tourism sector, while confinement measures led to a sharp drop in service activity and disrupted global value chains. Data shared by the Tourism Confederation of Madagascar indicated a 90 percent loss of revenue for the sector in 2020. Many planned tourism investment projects are significantly delayed, if not temporarily abandoned, as a result of the pandemic. Tourism operators benefitted from some limited financial measures implemented by the government (such as deferring certain payment deadlines) but the overall level of support was deemed insufficient by the sector.[184] The COVID-19 crisis for the tourism sector is also a major concern for protected areas and their populations. MNP lost close to €2 million in revenues from tourism in 2020 and again in 2021, and faced a critical financial crisis,[185] although international donors helped cover some management costs with emergency funds. Many protected areas were closed for much of 2021 and a few into early 2022 and faced degradation for lack of maintenance. Overall poverty levels increased and resource harvesting in protected areas saw a major uptick, with increases in bush-meat traps (25 percent), illegal hardwood, precious wood, and construction wood harvesting (eight percent, 19 percent, and 106 percent respectively), a 250 percent increase in primary forest deforestation and a 200 percent increase in secondary forest deforestation within National Parks.[186] Protected areas serve as a recourse in the case of emergency for vulnerable populations. Tourism is a valuable opportunity to allow protected areas generate revenues to the local population, but other alternatives should be developed. The COVID-19 pandemic has confirmed that when the protected areas do not generate revenue to the populations, their sustainability is highly threatened.

MOVING FORWARD

131. **There are a number of measures which could both strengthen management of the country's protected areas and conserve biodiversity while stimulating local economic development including tourism.** These can be categorized in three groups: sound management of protected areas, promotion of tourism and diversification of its offerings, and fair sharing of benefits with local communities.[187]

Manage Protected Areas Well

132. **A strong network of protected areas requires sustainable financing.** Conservation spending can address threats to natural assets and improve management when used to hire and train staff, invest in infrastructure for enforcement and tourism, manage wildlife and other natural resources, and promote outreach. Investing in protected areas with viable tourism can also subsidize other parks in which tourism is still to be developed or is not suitable. The FAPBM, one of the key successes of biodiversity conservation in Madagascar, provides an efficient way to transform intermittent donor funding into sustainable financing of protected areas. Its current endowment fund is capitalized with approximately US$138 million and is conservatively managed, allowing it to contribute about US$2.31 million annually to management costs. In order for it to finance the management costs of the entire protected area network its endowment would need to be increased very substantially to about US$1.75 billion. While an increase of this amount is unrealistic, increasing its capitalization would strengthen its financing power and would be one of the most efficient means of preserving Madagascar's unique biodiversity, and even more

184. IFC, 2021. Creating Markets in Madagascar. Country Private Sector Diagnostic. Available at: https://www.ifc.org/wps/wcm/connect/publications_ext_content/ifc_external_publication_site/publications_listing_page/cpsd-madagascar

185. The financial crisis was worsened by the fact that the government did not transfer the annual €450,000 envelope provided by the FAPBM sinking fund to MNP.

186. World Bank, 2021. SD Practice Group Note, contribution to the preparation of Madagascar CPF FY23-27.

187. World Bank, 2021. Banking on Protected Areas: Promoting Sustainable Protected Area Tourism to Benefit Local Economies. Washington, DC: World Bank. Available at: https://openknowledge.worldbank.org/handle/10986/35737 License: CC BY 3.0 IGO

modest fundraising would allow it to ensure basic operating costs of protected areas.[188] While recognizing resource constraints, there is also scope for the Government of Madagascar to begin public funding of the protected area system.

133. **And there is potential to build on the success of recent REDD+ initiatives to expand payment for environmental services.** Already approved, the Atiala-Atsinanana Emission Reductions Program (financed by the Forest Carbon Partnership Facility Carbon Fund)[189] will provide 58 percent of its US$50 million budget (total of US$29 million) over five years to validated REDD+ Initiatives, based on verified reduced deforestation, forest degradation, and enhancement of forest carbon stocks. These REDD+ Initiatives are for the most part protected areas: Masoala National Park and other protected areas managed by MNP, COMATSA Protected Area managed by WWF, Makira National Park managed by WCS, and CAZ managed by CI. LMMAs, similarly, have opportunities to take advantage of REDD+ initiatives, for example in "blue carbon" sequestration through sea grasses and other coastal and marine species and ecosystems. There is a growing carbon market, and while mangroves are well established now in this market, seagrass meadows are gaining interest. In addition to the carbon market, there is also the opportunity to use this type of blue carbon storage to meet national NDCs as well as biodiversity commitments.

Recommendations

(i) Increase the capitalization of the FAPBM;

(ii) Argue for some public funding of the protected area system; and

(iii) Expand opportunities for payment for environmental services, building on the REDD+ experience in both terrestrial and coastal/marine protected areas.

134. **The current informality surrounding new protected areas is a major threat to their management.** Many new protected areas have been created since 2015. However, most new protected area managers do not have a management delegation contract signed with the ministry responsible for environment. The ministry claims that most managers did not fulfill the obligations stipulated in their temporary delegation contracts and therefore cannot extend them, but did not provide the elements to explain this position. The managers are nonetheless de facto managing the protected areas for which they are responsible, but without a contract that would clarify their role and responsibilities. This situation is a major risk to the management of the protected areas, their legitimacy and that of the managers, as well as to community-based forest management more broadly. LMMAs, similarly, lack clear legal status including recognition of their role in marine biodiversity conservation, management of marine resources, and possibly climate change mitigation and adaptation. This should include its legal status in relation to existing biodiversity legislation and regulations, such as DINA and GELOSE, for example. This may require adapting the GELOSE to the marine context.

Recommendations

(i) Undertake an independent, transparent, and in-depth assessment of the performance of all delegated protected areas (including MNP, NGO, communities, and private sector) including LMMAs;

(ii) Based on the results of this assessment, adjust and formalize the legal status and management delegation contracts for all protected areas, terrestrial and marine;

(iii) Strengthen the ministry's capacity to monitor and evaluate the implementation of these delegation contracts;

(iv) Review and improve consistency between the GELOSE, the forest law, and the land tenure law, and local *dinas* for LMMAs. Address gaps in the legal and regulatory framework for community-based natural resource management and correct the inconsistencies between the different forest and environment-related texts;

(v) Strengthen the capacity of the State, both central government and regional services, to support community-based natural resource management policy;

188. See for instance: https://www.afd.fr/en/actualites/assessment-conservation-trust-funds-benefit-biodiversity WB and GEF contributions have so far totaled US$ 17.5 million

189. Forest Carbon Partnership. Madagascar Country Profile. Available at : https://www.forestcarbonpartnership.org/country/madagascar

(vi) Help address the financial constraints that VOIs, municipalities, and MPAs face through supporting expansion of performance-based payment schemes, taking for example advantage of REDD+ projects and programs; in MPAs use mangrove forests and sea grasses for carbon storage;

(vii) Review current and planned MPAs for climate change impacts and consider needed changes, especially for enabling some species to adapt to climate change, such as turtle nesting beaches or changes in protecting coral reefs in deeper cooler waters. Other changes include using protected areas to adapt to climate change and erosion control; and

(viii) Strengthen the capacity for law enforcement and the traceability of forest products. The role of the decentralized territorial units, particularly the municipalities, is crucial; they are in charge of the implementation of the two essential components for regulating access to renewable natural resources management: land tenure and spatial planning.

135. **Protected Area Management needs a range of skills including both conservation and tourism.** Successful protected areas have qualified managers who are well versed in protected area laws and policies, and also understand the business needs and obligations to conservation of tourism operators and commercial entities. As highlighted by IUCN,[190] these include planning and management skills in areas such as policy development, organizational leadership, financial and operations management, administration, communication, and collaboration. A recent assessment[191] of capacity building needs along the tourism value chain concluded that protected area managers and staff could benefit from capacity building in leadership, hospitality, commercialization, marketing, and negotiation of tourism opportunities, and languages. They also include protected area and biodiversity management, including scientific skills in ecosystems research, biodiversity conservation, upholding laws and regulations, and knowledge of flora and fauna, understanding the needs and rights of local communities, and ensuring that protected area governance meets their priorities, understanding and promoting economically and environmentally sustainable tourism and recreation opportunities, and promoting awareness and education about protected areas. Managing tourism concession programs requires skill sets that go beyond knowledge of wildlife management, and this capacity must be built. Experience from many countries has shown that centralizing conservation at the national level allows for better access to specialists and decision makers, and more policy consistency, while the day-to-day management of concessions is best accomplished at the protected area level by trained park managers.

Recommendations

(i) Review current education and training opportunities and develop priorities for filling key skills gaps in Madagascar, including through refresher courses and in-service training;

(ii) Adapt the conservation and tourism study paths: revise curricula and create new forms of tourism training that can be delivered in a short period of time (e.g., courses on demand) and target specific stakeholder groups; and

(iii) Build the capacity of protected area managers and staff in tourism planning, investment promotion, and the management of tourism concessions.

Promote Tourism in Protected Areas and Diversify its Offerings

136. **With adequate enablers, tourism in protected areas can make a greater contribution to the economy, jobs and financing of protected areas.** Many constraints faced by the tourism sector are beyond the scope of this note, but the post COVID-19 recovery provides an opportunity to assess and support rehabilitation needs both within and outside protected areas. The support to Nosy Be provided through the Second Integrated Growth Poles Project (before COVID-19), which improved infrastructure, services, and connectivity, and which helped trigger interest in renewed private sector investment, is an example. There is also a need for better understanding of the direct and indirect impacts of protected area tourism, tracking returns on protected area investments to better make the case for increased public spending, and for private sector engagement in protected areas. Surveys and information on park visitor numbers and tourist spending behavior can

190. IUCN, 2016. A Global Register of Competences for Protected Area Practitioners. Available at: https://www.iucn.org/sites/dev/files/content/documents/global_register_of_competences_for_pa_practitioners_e_version_0.pdf

191. Consortium, 2021. « Évaluation des besoins de renforcement des maillons des chaînes de valeur de l'industrie écotouristique à Madagascar. » Étude de faisabilité du projet de Résilience Climatique par la Préservation de la Biodiversité

be used to inform policies, improve services to tourists, assist local communities, refine tourism business models, understand the impacts of tourism and how they may change over time, and demonstrate the economic returns of investing in protected areas. The most recent such Visitor Survey at the national level in Madagascar dates back to 2012 and deserves an update.

Recommendations

(i) Assess post-COVID-19 infrastructure rehabilitation needs in protected areas, with a view to bringing them back to acceptable tourism standards;

(ii) Direct COVID-19 recovery financing toward the rehabilitation of protected areas;

(iii) Strengthen MNP's overall data collection, management, and dissemination methodologies, including on tourism;

(iv) Carry out regular visitor surveys to identify key areas for improvement and inform decision making; and

(v) Create a protected area tourism dashboard, assessing direct and indirect economic impacts of protected area tourism, linked to broader efforts to improve tourism data collection in the country.

137. **There is room for diversifying the tourism offerings in highly visited parks as well as diversifying into a greater number of protected areas and reviewing priority areas for tourist related investments more broadly.** As mentioned above, the last exercise identifying priority locations was undertaken in 2008 (see figure 4.3) and would benefit from an update. A new effort to re-assess the potential of all protected areas will allow the other protected areas outside the six most highly visited to be considered and developed while diversifying the ecotourism product. An update of the list of the priority areas has to involve the private actors to ensure that the review is market driven and realistic.

138. **Given the more recent development of marine protected areas and the potential for growth in coastal and marine tourism, there is scope for a particular focus on marine and coastal areas.** Marine and coastal tourism is best managed within a broader MSP process and ecotourism strategy. Marine tourism should not be only linked to marine protected areas. There are other areas of conservation importance outside the current MPA that have high potential in ecotourism, especially when led by private actors, such as marine wildlife watching. The development of such ecotourism will be beneficial for biodiversity conservation. Within protected areas there are opportunities for establishing partnerships between the tourism sector and LMMAs, and there are opportunities to draw on international experiences (e.g., Pemba in East Africa, Komodo in Indonesia for coral reef based ecotourism, the Azores, Seychelles, and others for whale watching) as well as from the experience of Blue Ventures in Madagascar. There may also be opportunities for fish-based tourism which may provide alternative livelihoods for fishers.

Recommendations

(i) Update the prioritization of protected areas for tourism investments with the private sector, based on past exercises, new global post-Covid tourism trends and investor appetite, and connectivity;

(ii) Prepare a national protected area tourism strategy identifying new protected areas for tourism, in partnership with the private sector, based on data and market intelligence, and nested within broader tourism development priorities for Madagascar;

(iii) In marine and coastal areas develop tourism strategies within a broader context of marine and coastal spatial planning;

(iv) Build on the experience of the Integrated Growth Poles Series of Projects (SOP) to support infrastructure, services, and connectivity improvements in priority areas;

(v) Prepare tourism strategies and action plans for protected areas that currently receive the most visitors, informed by visitor surveys and market analyses. These strategies and action plans should ideally be integrated in the different protected area management plans. They could identify the required investments to meet and maintain minimum standards and propose flexible upgrade plans, to be aligned with future means and needs;

(vi) Involve tourism professionals in the governance and management of key protected areas. This can be piloted in a one or two landmark protected areas at first;

(vii) Promote public private partnerships in ecotourism, both inside and outside protected areas and including marine and coastal areas; and

(viii) Support the national tourism office (Office National du Tourisme de Madagascar, ONTM) in strengthening its promotion of Madagascar as a biodiversity tourism hotspot.

139. **Tourism concessions in protected areas have the potential to promote tourism, improve local livelihoods, and support the financing of biodiversity conservation.** The section above summarizes Madagascar's experience with concessions over the last 15 years. Despite limited success to date, much of the background work has been undertaken and the current political context is favorable. Investors have expressed their interest, and the AfDB is preparing an investment in the sector.

Share benefits with local communities

140. **Deciding on increasing direct revenue sharing.** Sharing entry fee revenues, if done well, has the potential to greatly improve the ownership of the local population and their support to the protected area – which is less true for more indirect development projects. However, spreading (the currently low level of) revenues among many protected areas and communities would not achieve the level of adherence required to preserve the protected areas. There is therefore no simple choice between the two key approaches: (i) the current status quo of not sharing entry fee revenues until they reach an acceptable proportion of management costs; or (ii) engaging in a strategic revenue sharing maximizing the use of scarce resources (for example by implementing a direct, fair, and transparent sharing mechanism that focuses on the parks that generate tourism revenues).[192] A debate between key stakeholders and informed choice between both approaches should, however, take place to move from an unofficial situation to an informed and implemented strategy.

141. **Understanding income multipliers in order to maximize them.** Neighboring communities benefit from the economic activity spurred by tourists visiting protected areas. The economic impact of this activity through direct and indirect linkages, including but not limited to jobs, may be expressed as an income multiplier. It is likely to be among the most important protected area benefits that are shared with the communities. An in-depth understanding of these income multipliers, value-chains, opportunities, and constraints for the local population and businesses would allow the government to design and implement policies and programs to strengthen their economic impact. Examples include providing opportunities for tourists to interact with local communities; strengthening the capacity of local communities to provide goods and services to tourists; assisting households to participate in the tourism economy through entrepreneurship training, skills development, credit services, and logistics, among others; and supporting business diversification and local procurement. These benefits, once understood, may be distributed more fairly by including the poor and disadvantaged.[193]

Recommendations

(i) Explore and decide on an entry fee revenue sharing strategy, balancing their relative shortage and the need to increase the support of local communities for protected areas;

(ii) Undertake an in-depth assessment of protected area income multipliers, to strengthen the economic impact of protected areas; and

(iii) Improve regulatory framework for community-based natural resource management by improving consistency between the GELCOSE, the forest law, and land tenure law, for example.

CONCLUSIONS

142. **Madagascar's landscapes, coastlines, marine environment, and network of protected areas are unique.** There is great potential for them to contribute to economic development and poverty reduction if they are well managed, and with the right enabling environment. Many of the challenges faced are linked to broader development challenges of poor connectivity and lack of basic services, weak or incomplete legal and regulatory frameworks in areas ranging from land tenure to tourist concessions, poor public sector capacity and weak collaboration between institutions, and limited education and human resource development opportunities. But Madagascar also has a long experience in protected area management to draw on, and there are valuable lessons from other countries. With the return to political stability, the opportunity is there for the country to develop and manage its natural assets both to conserve its unique natural assets and to increase prosperity for the country's citizens. Recommendations are summarized in the Table 4.2 below.

192. The benefit-sharing mechanism put in place by the government of Madagascar in the framework of its REDD+ program could be a good source of inspiration, even though the expected amounts to be shared are much greater (US$50 million).

193. World Bank, 2021. Banking on Protected Areas: Promoting Sustainable Protected Area Tourism to Benefit Local Economies. Washington, DC: World Bank. Available at: https://openknowledge.worldbank.org/handle/10986/35737 License: CC BY 3.0 IGO

Table 4.2. Summary Table of Recommendations

Policy Objective	Study/Assessment	Legal/ Regulatory Change	Institutional/ Capacity Building	Investment	Implementation Responsibilities
Strengthen ministry capacity to monitor & evaluate implementation of delegated contracts	Assess performance of delegated protected areas; Review and ensure consistency of regulations for community based natural resource management contracts (see also section on sharing benefits below)	Adjust & formalize management delegation contracts for these areas	Strengthen Ministry capacity to monitor & evaluate implementation of delegated contracts		MEDD, MNP and delegated park managers with technical assistance
Increase financing of protected areas			Communicate management record of FABM to relevant stakeholders: adequate funding to meet operational costs can free space to invest in communities	Increase capitalization of FABM & expand support to LMMAs; Explore additional mechanisms to raise funding	FABM with MEDD, MNP and international development
Improve capacity to manage protected areas	Review present education & training opportunities for protected area management		Support strengthening of local training institutions in relevant areas; Support in-service training to manage including tourism management	Ensure government funding of protected areas	MEDD, MNP, relevant training institutions with development assistance
Support post-COVID-19 recovery of protected areas	Assess post-COVID-19 infrastructure rehabilitation needs in protected areas, with a view to bringing them back to acceptable tourism standards			Direct COVID-19 recovery financing toward the rehabilitation of protected areas and their tourism infrastructure	MNP with relevant ministries and deconcentrated institutions, with support of tourism partners and international development partners, including through GIP 2

Policy Objective	Study/Assessment	Legal/ Regulatory Change	Institutional/ Capacity Building	Investment	Implementation Responsibilities
Diversify and improve the quality of tourism offerings	Update the prioritization of protected areas and coastal/ marine for tourism investments, based on past exercises, market surveys, travel preferences, new conditions and investor appetite, together with private sector		Prepare a protected area tourism strategy for (a) protected areas that currently receive most visitors; (b) new protected areas for tourism; and (c) coastal and marine areas, in partnership with the private sector & identify new investments;	Build on the experience of the Growth Poles Series of Projects to support infrastructure, services, and connectivity improvements in priority areas	Tourism industry, MNP, Ministry of Tourism, public works, decentralized territorial local authorities, MEDD/MNP with the support of development partners. Tourism industry with MNP and delegated managers including LMMAs and municipalities
			Pilot secondment of tourism professionals in the management of key protected areas and improve the integration of tourism and Protected Area Management more broadly; Support the national tourism office (ONTM) in its marketing strategy to refine messages on nature-based tourism		Growth Poles project Ministry of Tourism, national tourism office (ONTM)
Finalize regulatory framework for tourist concessions in protected areas	Discuss options in support of concession reform (among other measures)	Approve amendment of regulations	Finalize documents required (concessions decree, ministerial order; national concession strategy; standard contract). Update MNP's mandate to manage protected areas	Investment in support of finalization concession framework, building on reforms linked to special status lands (as part of larger package)	MNP, MEDD Ministry of Tourism, donors

Policy Objective	Study/Assessment	Legal/ Regulatory Change	Institutional/ Capacity Building	Investment	Implementation Responsibilities
			Promote public private partnerships in ecotourism, both inside and outside protected areas and including marine and coastal areas		
Share benefits with local communities	Undertake an in-depth assessment of protected area income multipliers, to strengthen the economic impact of protected areas; Explore and decide on an entry fee levels and revenue sharing strategy, balancing modest resources available with shortage and the need to increase the support of local communities to protected areas	Reform regulations if appropriate	Improve transparency of mechanisms for benefit sharing with local communities	Design & implement investment strategies to maximize multipliers	
Improve regulatory framework for community-based natural resource management natural resource management	Improve consistency between the GELOSE, the forest law, and the land tenure law	Address gaps in the legal and regulatory framework for community-based natural resource management and correct the inconsistencies between the different forest and environment-related texts	Strengthen the capacity of the State, both central government and regional services, to support community-based natural resource management	Help address the financial constraints that VOIs and municipalities face through supporting expansion of performance-based payment schemes, taking for example advantage of REDD+ projects and programs	MNP, MEDD, Forest Department, deconcentrated and decentralized agencies including communes and municipalities with assistance from development partners

Note: Blue refers to major policy recommendation; green refers to short term (1-3 years) policy recommendation; red refers to medium term (3-5 years) recommendation

Photo credit : Dennis van de Water/Shutterstock.com

5

MANAGING PERSISTENT AND EMERGING ENVIRONMENTAL CHALLENGES

143. Apart from challenges around integrated landscape management, Blue Economy, and nature-based tourism, which are reflected in the low productivity of Madagascar's natural capital, the quality of Madagascar's environment is also under threat, with corresponding impacts on human health and other development indicators. These health impacts of environmental degradation are also receiving increasing attention. Since 2018, the Government of Madagascar has been working to address some impacts through *the Health and Pollution Action Plan*,[194] an initiative led by MEDD and with the participation of the Ministry of Public Health, under the umbrella of the Global Alliance. It has identified three priorities: (i) to reduce indoor air pollution by replacing charczoal-burning stoves with clean fuels and technology; (ii) to reduce outdoor air pollution by monitoring and reducing emissions from vehicles, industry, and forest fires; and (iii) to address soil and water contamination by identifying the sources causing harm and cleaning up contaminated soil and water. Chapter 2 discusses programs to reduce indoor air pollution. This chapter analyzes three other key environmental challenges: ambient air pollution, solid waste management, which is a source of air, water, and soil contamination, and sustainable tourism. Effectiveness of current Environmental Impact Assessment arrangements to manage threats to the environment, particularly from infrastructure development, are also discussed.

194. Indiana University, 2018. Madagascar's Health and Pollution Action Plan. Available at: https://solvepollution.iu.edu/hpap/index.html

MINISTRY OF ENVIRONMENT AND SUSTAINABLE DEVELOPMENT

144. **The mission of the Ministry of Environment and Sustainable Development (Ministère de l'Environnement et de Développement Durable, MEDD) is to *"Safeguard and value our environment and unique natural resources for the well-being of the Malagasy population and the sustainable development of the country*.**[195] There are 15 regional directorates (some serve more than one region) providing "deconcentrated services." At the central level there are two general directorates. One is in charge of environmental governance including departments for natural resource management, for combating threats to the forest (including illegal logging), and for reforestation and landscape management. The second general directorate is for sustainable development, including for the green and blue economies, for payment for environmental services, for strategy and policy, and for integration, evaluation, and information.

145. **The Ministry includes additional key services and organizations.** Reporting directly to the Secretary General (under the Minister), is a Bureau for Climate Change, Carbon and Emissions Reduction from Deforestation and Forest Degradation, whose responsibilities includes climate change strategy, REDD+ strategy, carbon, and other external financing and evaluation. Other departments provide specialized services such as quarry management and health, medical waste and environment, and external relations. Furthermore, there are key semi-autonomous organizations which are under the umbrella of the Ministry — the National Office of the Environment *(Office National pour l'Environnement*, ONE) with oversight over environmental impact assessment, research and training institutes, the organization responsible for controlling marine environmental pollution (l'Organe de Lutte contre les Évènements de Pollution, OLEP) and Madagascar National Parks (discussed in Chapter 4).

146. **The mission of OLEP is to combat marine pollution from hydrocarbons.** OLEP is a public institution endowed with legal authority and with administrative and financial autonomy; its sources of finance include royalties paid by oil companies and fines collected for marine pollution caused by oil tankers. OLEP in practice only addresses the prevention of marine pollution by tankers and does not consider overall pollution, particularly down the value chain.

ENVIRONMENTAL IMPACT ASSESSMENT

147. **ONE has oversight over the environmental impact assessment of new investments.** It is guided by legislation adopted in 2015 — the Environment Charter and the MECIE Decree — which updates earlier laws.[196] New investments are subject first to an environmental screening process, which determines whether or not an EIA needs to be undertaken; they are categorized by the nature, size and sensitivity of the area of the investment. Once prepared, the EIA is reviewed by ONE and subject to public consultations. ONE may review draft terms of reference for the EIA, but this is not mandatory. If the investment is found acceptable, ONE issues an environmental permit with stipulations regarding mitigating measures and specifications to ensure compatibility with environmental standards as well as reporting requirements related to their implementation effectiveness. ONE's structure and recent work, including environmental permits issued per sector, are summarized in its May 2020 Activity Report.[197] The majority of these are for mining and industry; there are relatively few for infrastructure investments.

148. **Effectiveness of these institutions to manage environmental risks is constrained by limited human and financial capacity.** Environmental Units within key sectoral ministries[198] have responsibility for ensuring that sectoral

195. Development Bank of Southern Africa, 2021. Madagascar. Available at: https://www.dbsa.org/sites/default/files/media/documents/2021-05/Chapter%2014%20Madagascar.pdf

This website provides more details on the responsibilities of MEDD, including oversight of environmental standards, environmental impact assessment and climate change.

196. Law n°2015-003 of January 20th, 2015, and the MECIE Decree (Compatibility of Investments with the Environment), decree N° 99-954 of December 15th, 1999, amended by decree N° 2004-167, MECIE 'Mise en Compatibilité des Investissements avec l'Environnement', concerning the environmental impact assessment of all activities that could harm the environment.

197. Office National pour l'Environnement, 2020. Rapport d'Activities. Available at: https://www.pnae.mg/AttributionsPrincipalesONE-mai2020.pdf

198. Republic of Madagascar, 2003. Decree No. 2003-439 of March 27, 2003.

investments are compatible with environmental guidelines. These units are centralized in Antananarivo with limited staff. Through prefectural order, MEDD has also mobilized the establishment of regional environmental units in STDs; however, human and financial resources to staff these have not been allocated. Furthermore, capacity is lacking within ONE to ensure that project promoters are respecting the guidelines laid down in environmental permitting documents. This is the case also for the Hydrocarbons Marine Pollution Incident Response Body and OLEP, which reports to both the MEDD and the Ministry of Finance. There is no certification system for environmental assessment practitioners in Madagascar.[199] The guidelines merely encourage the proponent to use recognized scientific experts in conducting the EIA and the names, professions, and functions of each EIA team member must be provided in an annex to the EIA report. Also, guidelines for sectoral EIAs are often not provided, such as for the road and water infrastructure. Except for forestry, furthermore, MEDD lacks judicial capacity to assess and investigate environmental offenses. An ongoing reform process in the environmental code is intended to address this but has not been completed.

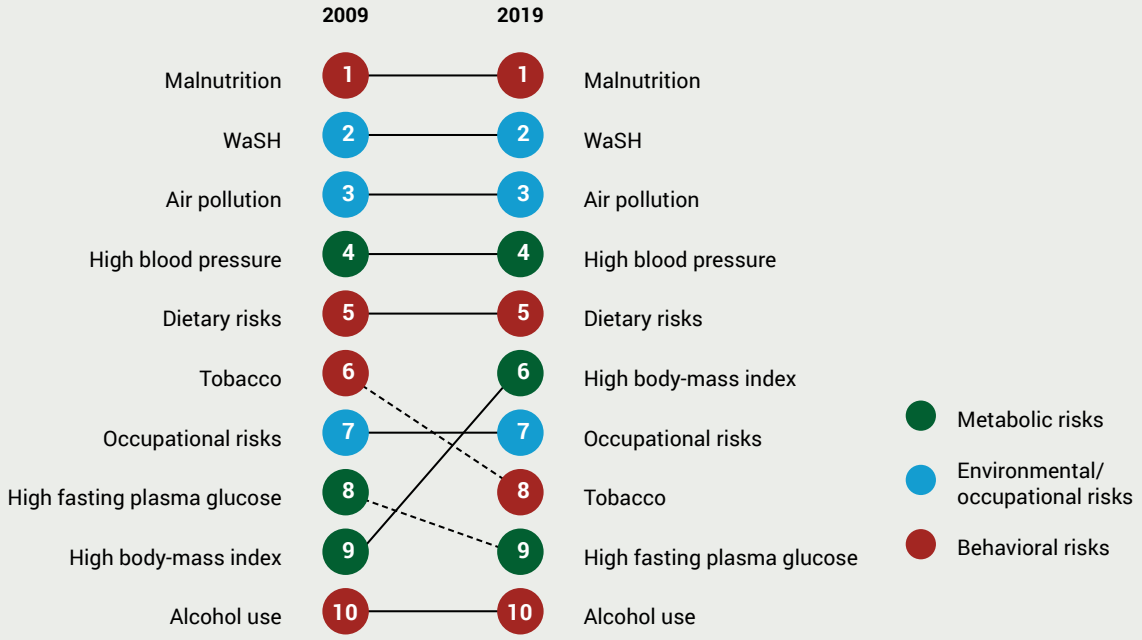
149. **A further limitation is that country-specific environmental quality and emission norms and standards have been adopted only for a few sectors.**In most cases, regulations are based on international standards and are not necessarily based on experience in Madagascar.

150. **ONE to date has focused on preventing the negative impacts of investments but efforts are under way for the revision of 2015 MECIE decree,** which is intended to address incentives for investments in greener initiatives, including recycling. In the revision process, the intention is that EIA will also address social impacts; investment would thus be subject to broader ESIA (environmental and social impact assessment). The aim is also that, as part of the decentralization process, CTDs will play a greater role in environmental management.

AMBIENT AIR POLLUTION

151. **Air pollution remains the third largest risk factor for deaths and disability in Madagascar,** after malnutrition and poor water and sanitation services (Figure 5.1), with no change between 2009 and 2019.

Figure 5.1. Top 10 Risks Contributing to Total Number of DALYs in 2019 and Percent Change (2009 – 2019, all ages combined)



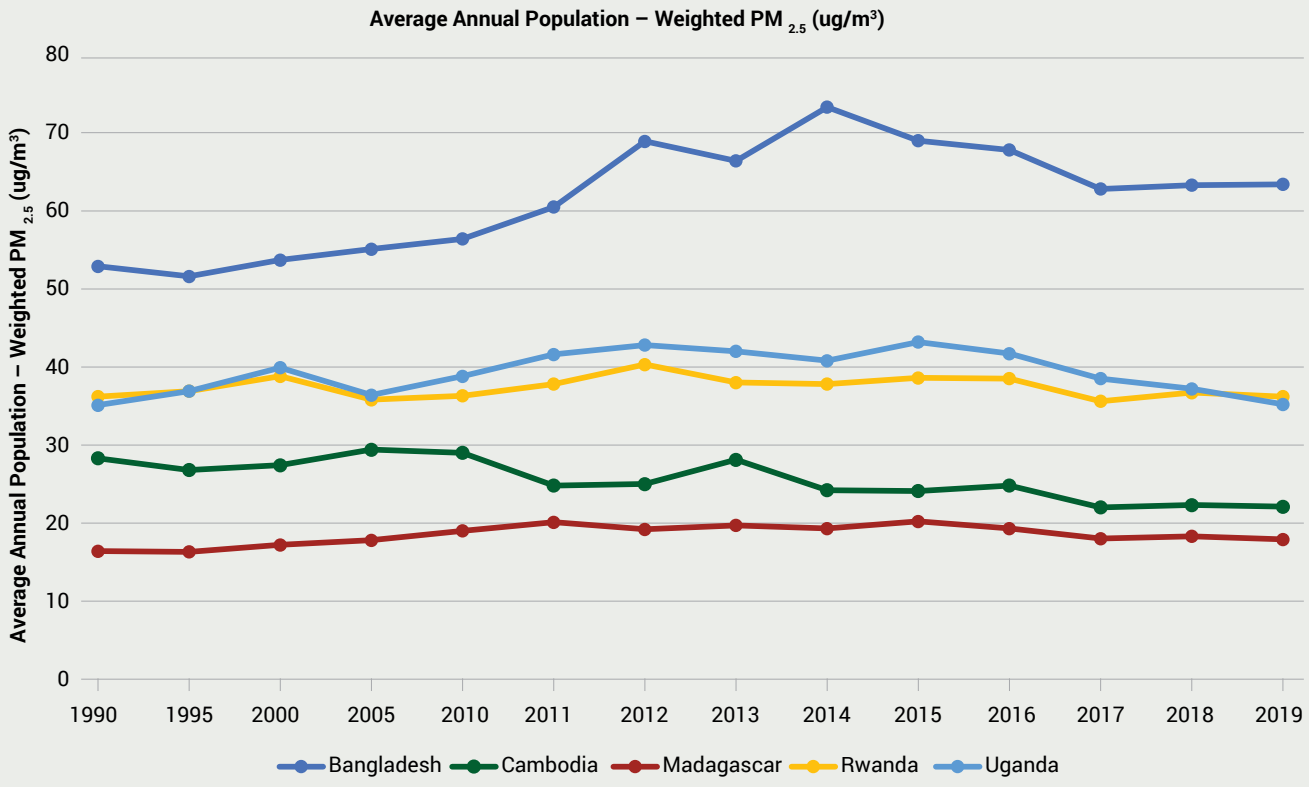
Source: GBD (2020) http://www.healthdata.org/madagascar

199. DBSA, 2021. Madagascar. Section 14.3.10. Available at: https://www.dbsa.org/sites/default/files/media/documents/2021-05/Chapter%2014%20Madagascar.pdf

152. **However, indoor air pollution drives the health impacts of air pollution, and ambient air pollution is not currently a challenge.** Madagascar shows an increase in ambient $PM_{2.5}$ concentration between 1990 and 2019. While average annual population-weighted ambient $PM_{2.5}$ concentrations increased slightly from 16.4 µg/m^3 in 1990 to 17.9 µg/m^3 in 2019, Madagascar's ambient $PM_{2.5}$ concentrations are well below the interim Target 1 established by WHO, and significantly lower than the global average and those of Madagascar's peer group countries.

153. **Addressing ambient air pollution will be of increasing concern as Madagascar urbanizes.** Urban population growth rates are currently about 4.5 percent per year,[200] with 39 percent of the population living in towns and cities, compared with rural population growth rates of 1.5 percent per year. Antananarivo is by far the largest city in Madagascar, with a current population estimated at 3.5 million, and a growth rate of nearly five percent per year.[201] Air pollution is for example an emerging challenge in Antananarivo, in some seasons (see Box 5.1). The government's Health and Pollution Action Plan (HPAP) estimates deaths from ambient air pollution at 8,500 annually.[202] The MEDD through the Department of Pollution, Waste Management and Integration is in charge of data hosting and data analysis on air pollution in Antananarivo. The data have been collected daily in five hotspots of the capital since November 2020. Air monitoring stations are available to measure Particulate Matters (PM), carbon monoxide, hydrocarbons, nitrogen oxides, and sulfur dioxide. Ambient air quality levels are monitored only in Antananarivo, and the results are not made public on a routine basis.

Figure 5.2. Average Annual Populated-Weighted Concentration of Ambient $PM_{2.5}$



Source: Health Effects Institute. 2020. State of Global Air 2020.
Data source: Global Burden of Disease Study 2019. IHME, 2020.

200. WDI, 2022. Available at: https://data.worldbank.org/country/MG

201. Macrotrends, 2022. Antananarivo, Madagascar Metro Area Population 1950-2022. Available at: https://www.macrotrends.net/cities/21792/antananarivo/population#:~:text=The%20metro%20area%20population%20of,a%204.97%25%20increase%20from%202018

202. Global Alliance on Health and Pollution, 2018. Madagascar Health and Pollution Action Plan. Available at: http://gahp.net/wp-content/uploads/2019/07/Madagascar-HPAP_EN.pdf

Box 5.1. Air Pollution Trends in Antananarivo

Though not an issue nationally, ambient air pollution is a recurrent problem in the concentrated urban area of Antananarivo. In 2021, air quality monitors in Ambohidahy recorded an average annual concentration of 45 g/m^3 $PM_{2.5}$, higher than the WHO recommended interim Target 1 of concentration of 35 µg/m^3. The highest peak of 72 g/m^3 was recorded in November. Poor ambient air quality in the urban area of Antananarivo is noted to be caused by various emission sources including road traffic, open burning of waste, bush fires from the perimeter of the urban area, industrial emissions, and smoke emissions from brick kilns.

Source: MEDD, 2022. Statistics on air pollution in Antananarivo, DPDIDE, MEDD.

154. **Ambient air pollution has multiple causes.** In Antananarivo these include vehicle emissions, emissions from industry, brickyards, fumes from solid waste burning in landfills and wild dumps, and a reliance on solid biomass (e.g., wood, crops) for cooking. Analysis has not yet been undertaken on the relative importance of these different sources, but poor-quality fuel emission standards for vehicles, including both cars and lorries, are a major cause. The HPAP notes that the two primary drivers of increasing levels of particulate matter are the high sulfur fuel imported to Madagascar that is referred to as "African quality" diesel; and the used vehicles imported to Madagascar which are less efficient and lack basic environmental controls.

155. **Vehicle ownership is still low, though growing, and Madagascar does not have modern vehicle or fuel quality emission standards.** Vehicle ownership was estimated at 27 per 1000 population in 2015,[203] but it is growing steadily, with car ownership concentrated in the capital. Demand is significant in particular for used cars, on which Madagascar has not yet implemented restrictions. Other countries in the region have implemented restrictions based on the age, mileage, or emission standard of the vehicle.[204] However, introduction of import restrictions increases costs, including for small businesses, and requires careful public relations campaigns. It requires capacity to enforce regulations; in some countries it has resulted in widespread smuggling. Madagascar has also been slow to introduce modern quality standards for gasoline and diesel. Leaded gasoline was banned in 2006,[205] but imports of low-quality fuel with high sulfur levels are permitted; maximum sulfur standards for gasoline at 2,000 ppm.

156. **There is scope for taking a proactive approach to mitigating urban air pollution, which is likely to become more acute, especially in Antananarivo.** The first step would be to establish ambient air quality standards accompanied by improved air quality and emissions monitoring so that there is clearer understanding of the extent of the problem and its principal sources. Air quality information should also be shared regularly with the public. This will help build ownership for future reforms. As stricter emission standards for vehicles are introduced, these must be accompanied by capacity building to provide for regular vehicles emissions testing. Traffic management can also help mitigate pollution. Other countries, such as Bangladesh, have supported cleaner production methods for bricks; if this is identified as a major pollution source, similar support measures could be considered. Over time more incentives for switching to cleaner cooking sources (ethanol, LPG, and solar energy) will be necessary, mitigating the impact of uncontrolled burning of waste.

202. Wikipedia, 2022. List of countries by vehicles per capital. Available at: https://en.wikipedia.org/wiki/List_of_countries_by_vehicles_per_capita

204. Jane Akumu, 2019. Africa's Progress to Cleaner Fuels and Vehicles. UNEP. Available at: http://airqualityandmobility.org/PDFs/sadc2019/OverviewAfricaprogress.pdf

205. Republic of Madagascar, 2006. Order No. 155/2006 of January 4, 2006 setting the specifications for unleaded gasoline.

SOLID WASTE MANAGEMENT

157. **Though data on the extent and nature of the solid waste management challenge are scarce in the country, this is noted to be a growing challenge.** In 2016, it was reported that Madagascar produced 3,769,000 tons of municipal solid waste per year with a population of 24,895,000,[206] 0.41 kg/per capita/year and about half the global average (see Table 5.1). Tourism hotspots such as Nosy Be and Ile Sainte Marie are said to produce a higher amount of waste than the national average. Furthermore, it is reported that 96.7 percent of waste ends up in open dumps. If open dumps are near the coast or if rivers are used as dump sites, then much of it will likely end up in the ocean, adding pollutants, including plastics.

158. **Generation of waste is increasing, and Madagascar faces increasing challenges in waste management.** Up to date information is lacking, but a 2014 study estimated generation of 18,003 metric tons of hazardous waste, 173,129 metric tons of recoverable waste and 689,850 metric tons of household waste (Table 5.2). Household waste constitutes by far the largest proportion of waste. As noted, waste generation, including of plastics, is not high by the standards of comparator African countries; the challenge is collection and safe management.[207] A recent World Bank Publication[208] illustrates that for low-income countries like Madagascar the majority of waste generated is either not collected (61 percent), or disposed of inadequately (93 percent), in open dumps on land or along waterways. Waste is also not sorted to facilitate management. Open dumping contributes to health risks from pests and fumes from uncontrolled burning, while when solid waste accumulates in waterways this not only pollutes the water but can exacerbate the severity of flooding as the waste can block drainage channels. Stagnant water from blocked drains can also contribute to the spread of insect borne diseases.

159. **Marine plastics are found throughout the coast of Madagascar, from remote beaches to urban areas.** While there are no historical studies to establish a baseline, a 2007 report that assessed marine litter and related waste management activities provides a comprehensive description of the situation at that time (Lane, 2007). The assessment found significant quantities of marine litter around urban areas, noting that

Table 5.1. Waste generation rates for Madagascar and peer countries adjusted to 2016

	Waste Generation (2016 adjusted tons)	Population (2016 adjusted)	Waste generation Rates (kg/capita/day)
Global Average			0.74
Madagascar	3,768,759	24,894,551	0.41
Bangladesh	16,380,103	162,952,000	0.28
Cambodia	1,159,859	15,762,000	0.2
Rwanda	4,384,969	11,917,508	1.01
Tanzania	10,860,140	55,572,000	0.54
Uganda	8,375,073	41,488,000	0.55

Note: Data adjusted to 2016. Source: "Kaza, Silpa; Yao, Lisa C.; Bhada-Tata, Perinaz; Van Woerden, Frank. 2018. What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050. Urban Development; Washington, DC: World Bank. © World Bank. https://openknowledge.worldbank.org/handle/10986/30317 License: CC BY 3.0 IGO."

206. World Bank. 2016. "Integrated Urban Development and Resilience Project for Greater Antananarivo (P159756): Project Information Document/ Integrated Safeguards Data Sheet (PID/ISDS)." Concept Stage. Report No. PIDISDSC17608. Washington, DC: World Bank Group.
207. WWF, 2022. Plastic Pollution in Africa: Identifying Policy Gaps and Opportunities. Available at: https://wwfafrica.awsassets.panda.org/downloads/wwf_plastic_pollution.pdf?38342/plastic-pollution-in-africa
208. Kaza, Silpa; Yao, Lisa C.; Bhada-Tata, Perinaz; Van Woerden, Frank, 2018. What a Waste 2.0 : A Global Snapshot of Solid Waste Management to 2050. Washington, DC: World Bank. Available at: https://openknowledge.worldbank.org/handle/10986/30317 License: CC BY 3.0 IGO.

Table 5.2. Waste Estimation in Madagascar (in metric tons)

Type/Category	Hazardous waste	Recoverable waste	Household waste
Batteries and accumulators	4,940	-	-
Lamps, neon lights	1,000	-	-
Mineral oils	6,906	-	-
Car batteries	3,039	-	-
Refrigerants	524	-	-
Healthcare waste	1,594	-	-
Paper and paper boxes	-	89,681	-
Metals	-	13,797	-
Plastics	-	68,985	-
Tires	-	66	-
Household waste	-	-	689,850
TOTAL	**18,003**	**173,129**	**689,850**

Source: Initiative on Cities, 2014.

one coastal city collected 100m^3 of plastic per day. At that time, illegal dumping accounted for 50-70 percent of solid waste, with the coast seen as a cost-free disposal place. The study found management to prevent solid waste entering the ocean was inadequate in terms of institutional arrangement, technical compliance, and waste management services. More recent studies of marine litter in Madagascar at specific sites show that much of the litter is plastic and includes bottles, films, packaging, and fishing gear. The relative quantities depend on the site (Gjerdseth, 2017). Ongoing surveys at four locations around Madagascar found the origin of the plastics is primarily domestic for surveys close to urban areas, while more remote locations have plastics from international locations (Saloma et al., 2021). Southeast and South Asia are major sources of plastic debris. Some plastics also originate in Somalia (van der Mheen et al., 2021; Pattiaratchi et al., 2022). There is a need for a footprint analysis to better understand the extent of marine plastics in Madagascar including imports, production, and disposal. This work can inform the transition to a circular economy for plastics. In addition, the prevalence of marine plastics originating outside of Madagascar justifies the country extending their participation in regional and global efforts to reduce marine litter.

160. **Responsibility for waste regulation is shared between MEDD and the responsible sectoral ministry.** Healthcare waste is under the direct supervision of the MEDD and the Ministry for Public Health (Law N° 2011-002 of July 15, 2011 on the Health Code). Industrial waste and traded goods are under the supervision of the MEDD and the Ministry of Trade Industry and Consumer Goods (Law N° 99-021 of August 30, 1999 on management and control of industrial pollution policy). However, although regulations specify that the costs should be met by firms, there are no further specifications on management of industrial solid waste. Waste discharged into water is under the supervision of MEDD and the Ministry of Water, Sanitation and Hygiene. (Law N° 98-029 of January 20, 1999 on the Water Code). Waste affecting the territorial planning is under the direct supervision of the Ministry in charge of Territorial Planning and Land Administration (Ordinance N° 92-033 of July 17, 1992 amending certain provisions of Ordinance N° 60-167 of October 3, 1960 relating to town planning). While there are regulatory gaps, the bigger challenge is human resource capacity to communicate and enforce regulations, and to adapt existing standards to local conditions.

161. **Responsibility for waste collection is the responsibility of the municipalities (CTDs).**[209] Waste collection and disposal can be undertaken either directly by municipalities, or it can be contracted to specialized bodies. Fees can be levied on citizens to cover costs. In practice there are financial and organizational constraints, even in Antananarivo, which has the highest waste management budget, and where the quantity of waste generated is sufficient to enable economies of scale in sorting, disposal, and recycling. Antananarivo is, however, benefitting from assistance from the French Development Agency (Agence Française de Développement, AFD) in waste management, linked to the WBG supported Integrated Urban Resilience and Recovery Project for Greater Antananarivo.[210] AFD is providing an EU€2 million grant to the Autonomous Maintenance Service of the City of Antananarivo (SMA) in order to secure and reorganize the operations of the landfill, Andralanitra, 10 km from the city center, filled to above capacity and a source of pests, water, land and air pollution. The city's longer-term goal is to build a new landfill further from the city but in the meantime remedial measures for Andralanitra are required. The WBG supported First Growth Poles project (PIC1) has also supported improved municipal services in some towns. For example, support was provided to Andoany (formerly Hell-Ville), the principal town in the tourist island of Nosy Be, for creation of a solid waste management enterprise (EGEDEN), which was able to increase the number of people provided with solid waste collection services from 25,000 in 2005 to 75,000 in 2013. The Second Growth Poles project is also financing small civil works for improved service delivery in water supply, solid waste management and rural electricity in targeted communes.

162. **Informal waste recovery is significant but difficult to quantify.** Waste recovery is undertaken mostly by waste pickers, whose work is difficult and dangerous. It is difficult to quantify either the number of workers the sector sustains or the economic impact. Despite the emergence of some local recovery channels (for example in paper recycling), and strategies for plastics recycling, most recoverable waste is exported to Asia (mainly metals) and most waste, including hazardous waste, is not treated.

163. **MEDD is aware of the potential for creation of energy from waste.** Examples include the generation of energy from communal biogas power plants paid for by electricity fees. The intention is to work with private sectors and decentralized territorial collectivities (municipalities) in support of "green" bankable local projects. One option would be creation of a "local investment fund for sustainable development" *(Fond d'Investissement pour le Développement Durable,* FILDD) which could be anchored with existing funds like the Local Development Fund.

SUSTAINABLE TOURISM DEVELOPMENT

164. **While tourism is a driver of economic returns that can support environmental conservation,**[212] **if not carefully planned and managed, it can also generate negative environmental impacts.** Such impacts can include human pressures on natural assets through visitation, generation of greenhouse gasses through transportation services, excessive water use by hotels and large-scale solid waste generation.

165. **Globally, a number of efforts and commitments have been made to limit tourism's negative environmental impact and to ensure a more sustainable approach to tourism development.** For instance, the UN World Tourism Organization's Global Code of Ethics for Tourism (GCET), established in 1999, aims to help maximize the sector's benefits while minimizing its potentially negative impact on the environment, as well as on cultural heritage

207. WWF, 2022. Plastic Pollution in Africa: Identifying Policy Gaps and Opportunities. Available at: https://wwfafrica.awsassets.panda.org/downloads/wwf_plastic_pollution.pdf?38342/plastic-pollution-in-africa

208. Kaza, Silpa; Yao, Lisa C.; Bhada-Tata, Perinaz; Van Woerden, Frank, 2018. What a Waste 2.0 : A Global Snapshot of Solid Waste Management to 2050. Washington, DC: World Bank. Available at: https://openknowledge.worldbank.org/handle/10986/30317 License: CC BY 3.0 IGO.

209. Republic of Madagascar, 2015. Law 2014-020 of September 27, 2014 on the resources of Decentralized Territorial Collectivities, election procedures, and the organization, operation and powers of their bodies, as amended by Law No. 2015-008 of March 20, 2015.

210. Agence Francaise de Developpement, 2017. Improving Waste Management in Antananarivo. Available at: https://www.afd.fr/en/carte-des-projets/improving-waste-management-antananarivo

211. World Bank, 2018. Madagascar – Integrated Growth Poles and Corridor SOP2 Project (English). Washington, DC: World Bank Group. Available at: http://documents.worldbank.org/curated/en/348081537500634040/Madagascar-Integrated-Growth-Poles-and-Corridor-SOP-2-Project

212. Chapter 4 provides more details on the potential for tourism.

and societies. A plethora of international green certification and standards programs provide tourism operators with recognition for applying sustainable practices in their operations. In 2019 UNESCO and Expedia Group partnered to create the UNESCO Sustainable Travel Pledge, whereby tourism businesses commit to sustainable practices for protecting local cultures and the natural environment. The Pledge is considered an alternative to more complex green certifications, making it accessible to smaller and independent businesses. The sector's global commitment to environmental goals was recently reasserted through the Glasgow Declaration for Climate Action in Tourism, launched at the UN Climate Change Conference COP26 in November 2021, which aims to accelerate climate action in tourism towards Net Zero emissions as soon as possible before 2050.

166. **Global travel and tourism trends in the post-COVID context show a growing interest in sustainable and "responsible" travel.** For instance, UNWTO foresees "conscious travel" and "green travel" as two key trends for travel and tourism in 2022.[213] As such, a commitment to sustainable tourism is not only positive for a destination's natural assets but also for the destination's attractivity and competitiveness.

167. **Madagascar is committed to sustainable tourism development and sustainable practices within the sector.** The country's 2018 Tourism Policy Letter aimed to develop Madagascar as a destination recognized worldwide for its sustainable management and the exceptional richness of its natural, cultural, and human heritage. It confirmed its desire to promote competitive and responsible tourism that maximizes economic and social benefits, contributing in particular to poverty reduction and limiting negative effects. It also stated an objective to increase the number of foreign visitors to National Parks and Protected Areas in order to generate sustainable funding for biodiversity conservation.

168. **The Ministry of Tourism is currently leading a review of the country's tourism public policy,** supported by the World Bank's Second Integrated Growth Poles project. Although not yet public, the revised policy's vision for the sector is directly centered on sustainability, through a strengthened collaboration between the public sector as the sector's regulator, the private sector as the engine of growth, and the population as the custodians of the country's assets. An ongoing review of the country's Tourism Code, also supported by the Second Integrated Growth Poles project, has also prioritized integration of sustainability principles. One revised article specifies four principles for ensuring the sustainability of tourism investments, the first of which is to favor the respect of the environment and biodiversity.

169. **The sustainability of tourism depends not only on how the sector's development is planned and managed at the macro level, but also on how individual travel and tourism firms operate –** and how tourists behave – at the ground level.[214] While the policy environment in Madagascar is favorable to a sustainable approach to tourism development, challenges remain in implementing these policies. Key challenges at the **policy and planning level** include:

- **Scarce public funds:** The public budget allocated to tourism in Madagascar is low in comparison to other high-potential, emerging destinations. As such, overall public sector capacity for planning, implementing, and monitoring sustainability programs is limited and actions have to be prioritized.
- **Fragmented planning:** Tourism sector development in Madagascar does not follow a master plan at the national level, hindering adequate investments in related infrastructure and services (e.g., energy, water, sanitation and waste management) that would contribute to effective destination management and limit negative environmental impacts. Tourism planning is also not coordinated with environmental authorities. Planning and management at the local destination level is also often fragmented.
- **Limited data collection:** An overall lack of data collection across the tourism sector prevents systematic monitoring of sustainability efforts and performance of firms and of destinations.

213. UNWTO, 2022. Tourism Trends 2022. Available at: https://www.unwto-tourismacademy.ie.edu/2021/08/tourism-trends-2022

214. Note: this section does not explore the behavior of tourists, focusing rather on the actions of the public and private sectors to ensure sustainability.

- **Challenging concessions framework:** The legal framework for concessions inside Protected Areas is incomplete and lacks transparency (see Chapter 4). As such, tourism operations and activities inside Protected Areas that could potentially contribute directly to conservation objectives are limited in number across the country.
- **Poor enforcement of rules at site level:** Even where tourism sites, including natural sites and Protected Areas, have guidelines in place for visitation and management plans, enforcement on the ground is often weak due to limited capacities, potentially leading to inappropriate contact of tourists with natural resources (e.g., mooring of boats in inappropriate marine zones, picking of plants).
- **Key challenges at the operator level include:**
- **Lack of financing:** Particularly in the COVID-19 context, tourism firms lack the necessary funds to adopt sustainability practices, which often involve upfront capital investments (e.g., in solar panels, recycling stations). In addition, access to external financing from commercial banks for tourism operators, especially MSMEs, is extremely limited and/or complex.
- **Limited technical capacities:** Many operators lack technical knowledge of sustainable practices and/or of the multitude of international standards and certifications initiatives to which they could apply.
- **Poor local infrastructure/service provision:** In many cases, operators are prevented from applying sustainable practices due to a lack of local infrastructure and services such as solid waste management services, water treatment centers, etc. with which their firm-level actions would integrate.

170. **Multiple programs and initiatives have been undertaken over the years to support the application of sustainability principles in tourism development and operations in Madagascar.** While reviewing all such programs is far beyond the scope of this chapter, some key initiatives identified through consultations are summarized below.

THE INTEGRATED GROWTH POLES SERIES OF PROJECTS

171. **The World Bank-financed Integrated Growth Poles Series of Projects takes a multisectoral, spatially focused approach to sustainable tourism development.** The development objective of the project currently under implementation, the Second Integrated Growth Poles project, is to contribute to the sustainable growth of the tourism and agribusiness sectors by enhancing access to enabling infrastructure and services in certain regions of Madagascar.

172. **The project focuses on a number of regional destinations that have been identified as having particular potential for private sector tourism growth.** In its lifetime, the Series of Projects has intervened in the tourist hub island of Nosy Be in the north, in Diego in the north, in Fort Dauphin in the far south, in Tulear in the west, and in Ile Sainte Marie off the east coast of the mainland, while also supporting authorities and private sector entities at the national level. Each of these "growth poles" is identified as having unique tourism development potential largely due to their terrestrial and marine natural assets and existing clusters of tourism enterprises with the potential for growth. The project works to improve their planning, management, and competitiveness through, for instance, institutional capacity building, financing, and technical assistance to entrepreneurs and startups, investment in local infrastructure and service delivery, promotion of private investment, and direct investment in specific tourism attractions, including Protected Areas and natural sites.

173. **The project has demonstrated that monetization of natural resources can help protect them, improve their governance and create jobs,[215] but also recognizes the potential negative impact of increased tourism.** Activities in Nosy Be have been particularly impactful, by combining local-level efforts to (i) crowd in large investments and strengthen local SMEs; (ii) upgrade infrastructure and basic services; (iii) strengthen governance; and (iv) upgrade and improve management of natural and cultural sites, with support for improving the overall investment climate at the national and regional levels. By

215. For instance, in Nosy Tanikeley, a marine Protected Area near Nosy Be, Tsingy Rouge in Diego, Montagne des Français in Diego.

2014, Nosy Be was on Lonely Planet's top 10 list of islands in the world and visitation quadrupled from 25,000 visitors in 2005 to 100,000 in 2019. However, recognizing the potential for negative cumulative impacts of this development, and in the context of the design of a new planned US$150 million investment project following the Integrated Growth Poles model that will continue to intervene on the island,[216] the World Bank undertook a Strategic Environment and Social Impact Assessment (SESA) of tourism development in Nosy Be. At the time of writing, the SESA had not been publicly disseminated, but its purpose is to identify and prioritize risks of negative social, environmental, and economic impacts of continued tourism development, and develop mitigation strategies based on growth projections.

174. **The project has recently implemented a new mechanism to support operators in their sustainability efforts.** In 2021, under the current project phase, a COVID-19 crisis-response capacity building and co-financing program for tourism enterprises was rolled out in the project's target regions.[217] The objective of the program was to support tourism operators' survival through the crisis and their subsequent resilience and competitiveness for the recovery. The five subject areas covered by the program included "Sustainable Management of Tourism Operations," which attracted 35 percent of all co-financing applicants (99 individual operators), indicating a strong interest in sustainable practices among operators across the country. The vast majority of project proposals under this subject area were for the purchase and installation of renewable energy sources (e.g., solar panels).

175. **In its recently launched third phase, the Economic Transformation for Inclusive Growth project, the Series of Projects will further strengthen its environmental sustainability focus.** It will do so through (i) greater integration of environmental sustainability principles and collaboration with environmental stakeholders in public sector planning at the national level; and (ii) facilitating the adoption of sustainability practices at the firm level. This enhanced focus is aligned with the revised public policy for tourism and the World Bank's corporate environmental commitments.

GREEN LABELS AND CERTIFICATIONS

176. **In 2006 the World Bank, under the first Integrated Growth Poles project (PIC1), supported the establishment of a Green Charter ("Charte Verte").**This was a declaration of commitment to tourism development based on planning and on a sense of partnership between the public authorities, the private sector, and civil society. Firms adhering to the Charter declared their commitment to implementing a set of guidelines and codes of conduct, tailored to the type of firm or operator (e.g., hotels, tour operators, transportation service providers). Firms also agreed to establish indicators that allowed environmental, social, and economic evaluation of their operations and investments (e.g., related to infrastructure provision, solid waste disposal and a code of ethics). However, no specific criteria had to be fulfilled or verified by any third parties, limiting enforcement of those codes. In addition, an Evaluation Committee intended to review firms' self-evaluations was not a success.

177. **In 2011, GIZ, in collaboration with a grouping of private tourism operators in Nosy Be and supported by the Nosy Be Regional Tourism Office, financed the development and rollout of a "Sustainable Tourism Charter for Nosy Be."**[218] Alignment with the charter required fulfillment of approximately 200 criteria and participation in an audit. Operators participated in environmental projects such as reforestation and waste collection activities, as well as social projects. Very limited public data suggests that around 70 operators in Nosy Be had signed the charter by 2015. The charter appears to have been adapted to some other destinations within Madagascar (Diego, Mahajanga), but with limited engagement.

178. **ONE created a "Green Label" for hotels in Nosy Be.** However, the political crisis in 2009 and the resulting crash in tourism effectively ended the labeling program, which has not been revived to date.

216. World Bank, 2022. Economic Transformation for Inclusive Growth Project. Project Details. Available at: https://projects.worldbank.org/en/projects-operations/project-detail/P174684

217. The "Mandrisika" program, available in Diana, Anosy, Atsimo-Andrefana, the island of Sainte Marie. Operators in Analamanga were also eligible for the program due to an exception opened for the COVID-19 context. Available at: https://mandrisika.mg/

218. In French, entitled "Nosy Be s'engage pour un tourisme durable".

179. **Few tourism operators in Madagascar are certified or accredited under international programs for sustainability or environmental management.** For instance, three hotels in Madagascar are currently certified by the international Green Globe system, a Global Sustainable Tourism Council (GSTC) recognized standard.[219] The Green Globe system assesses and certifies the sustainability performance of travel and tourism businesses and their suppliers according to 44 environmental, sustainable management, social economic, and cultural heritage criteria. It offers three levels of certification. There are 33 certified hotels in Africa. One hotel in Madagascar has earned the Green Key label, an eco-label established in 1994, representing a commitment to 130 criteria set by the Foundation for Environmental Education (FEE) and is also GSTC-recognized. Twelve tour operators and travel agents are partners of or are certified by Travelife, a GSTC-recognized standard for incorporating social and environmental criteria into operations.[220]

180. **Some clusters of tourism operators in Madagascar have shown a particular commitment to sustainable practices.** In Sainte Marie, an island beach destination that relies heavily on tourism income, many operators have come together to push for, for instance, the eradication of the use of plastic straws in hotels and restaurants. One hotel has successfully eliminated plastic water bottles. Local tourism firms also collaborate with environmental organizations to raise awareness of the negative impacts of plastic waste, organize beach clean ups, etc.

181. **Madagascar's tourism sector will take time to recover from the COVID-19 pandemic, and growth in the short- and medium-term will continue to be hindered by binding constraints as outlined in Chapter 4. In addition, long term development of the sector depends, critically, on sustainable management of the country's unique natural assets,** including its marine and coastal ecosystems, its biodiversity and landscapes, as well as its cultural heritage.

Recommendations for ensuring this sustainable management could include:

- **National-level planning:** Strengthen tourism development planning at the national level, particularly through enhanced public-private dialogue and coordination with environmental authorities and Madagascar National Parks.
- **Local destination management:** Draw on international best practices in destination management to pilot a model for Madagascar that brings together municipalities, local tourism authorities, and business associations as integrated destination management entities for regional destinations and their key attractions.
- **Standards and certifications:** Support tourism operators both technically and financially, potentially in a group format, in selecting and implementing environmental management standards such as ISO 14001 and applying for international "green" certifications or labels.
- **Local infrastructure and services:** Scale up investments in local infrastructure and services in key tourism destinations, allowing tourism operators to "plug in" to more effective basic services and upgrade their in-house sustainability efforts (e.g., water treatment, solid waste collection).
- **Access to finance:** Replicate and/or scale up programs such as Mandrisika that support tourism operators in understanding and applying sustainability practices through both (i) technical capacity building, and (ii) access to finance for implementation.

CONCLUSIONS AND SUMMARY OF RECOMMENDATIONS

182. **This chapter has discussed both long-standing and emerging environmental challenges. There are three main lessons moving forward.** These all apply to the growing challenges of ambient air pollution and solid waste management and to sustainable tourism:

    1. Cross-sectoral coordination at both central and local level is essential.

219 Green Globe. Available at: https://www.greenglobe.com/

220. Travelife. Awarded Companies. This list is non-exhaustive. Available at: https://www.travelife.info/index_new.php?menu=certifiedcompanies&lang=en

2. Involving and supporting the CTDs, especially at communal and municipal level, will help build local ownership, solutions adapted to local circumstances, and sustainability.
3. While the broad policy and strategy framework may be favorable, the main challenge is implementation. This involves capacity building especially at local level, targeted investments, financial incentives to encourage cleaner, greener transitions, and longer term educational and vocational training programs.

Each of the four areas covered in this chapter will be addressed through the lenses of these three cross-cutting recommendations.

Environmental Impact Assessment

183. **Environmental impact assessment and management plans need to support resilient, green, and inclusive development.** While environmental impact procedures exist, they are currently focused on avoiding negative impacts rather than supporting broader sustainable development. Procedures for strategic social and environmental impact assessment and plans are not routinely used, unless required for projects financed by international donors. Capacity is lacking in sector ministries, especially at the deconcentrated level, to ensure that social and environmental impact plans are implemented during project implementation.

Ambient Air Pollution

184. **Ambient air pollution is an emerging problem and already of concern in Antananarivo. Addressing the issue is likely to require regulatory and behavioral change, as well as financial incentives.** At present there is an insufficient understanding of the key sources, though vehicle emissions are likely to be a principal cause, together with poor traffic management, uncontrolled burning from solid waste dumps, dust from construction, cook-stoves, and brick kilns. Addressing the issue will require close cooperation with the municipal authorities, as well as community outreach, so that local businesses and the population understand reasons for tighter regulation. Before changes are introduced, furthermore, a thorough study of the costs, including on which groups these costs are likely to fall the most heavily, is necessary.

Solid Waste Management

185. **Improved solid waste management is a function of municipal, financial, and organizational capacity, of public awareness, and of the availability of viable options for recycling.** Generation of solid waste is likely to grow as Madagascar's economy grows, and there are opportunities to avoid the mistakes that other countries have made, including as regards single use plastics.

Sustainable Tourism

186. **Ensuring minimal environmental impacts of tourism recovery and growth will require sustainable use of natural assets and protected areas, and the mainstreaming of sustainability practices by the tourism private sector.** Recommendations include:

Table 5.3. Recommendations for Environmental Impact Assessment

Policy Objective	Instrument				Implementation responsibilities
	Assessment	Legal/Regulatory Reform	Capacity Building	Investment	
Use social and environmental impact assessment to contribute to sustainable development	Study existing legislation/ regulation and propose locally adapted revisions as appropriate	Introduce strategic social and environmental impact assessment/ planning where appropriate Incorporate costs of environmental and social mitigation into bidding documents	Support training and capacity building for sector-specific and ONE staff		ONE with sector ministries and local training/ educational institutions

Note: Where recommendations are in green they are for implementation in the short term (1-3 years); where they are in blue they are in the medium term (3-5 years).

Table 5.4. Recommendations for Ambient Air Pollution

Policy Objective	Instrument				Implementation responsibilities
	Assessment	Legal/Regulatory Reform	Capacity Building	Investment	
Develop air quality standards Reduce emissions from motor vehicles	Further assessment of principal sources of ambient air pollution in Antananarivo and other cities Study behavioral constraints and costs, including administrative costs of introducing tighter vehicle emission standards, including on imported vehicles Study traffic patterns and traffic management	Adopt WHO interim guidelines for air quality standards Revise fuel quality standards for sulfur content and other pollutants as necessary Revise vehicle emission standards for imported vehicles	Create vehicle emissions testing units in Antananarivo; Phase in similar programs for other major cities Make information on ambient air quality available on a weekly basis, using cost effective technologies for monitoring (satellite, low-cost sensors in combination with regulatory grade ground level monitors)	Support to establishment of emissions testing centers in Antananarivo Support establishment of air quality monitoring in major cities Support traffic management schemes to reduce pollution	MEDD, Ministry of Transport, Ministry of Industry, Trade and Consumption Municipality of Antananarivo, work through ongoing/ successor to Urban Resilience Project

Note: Where recommendations are in green they are for implementation in the short term (1-3 years); where they are in blue they are in the medium term (3-5 years).

Table 5.5. Recommendations for Solid Waste Management

Policy Objective	Instrument				Implementation responsibilities
	Assessment	Legal/Regulatory Reform	Capacity Building	Investment	
Support improved SWM, including safe disposal and recycling	Study SWM in secondary cities, including waste generation, and consider options		Support capacity building of municipal waste utilities Build local support for waste separation Build on AFD work to develop alternative livelihoods for waste pickers in Antananarivo	Support construction of new landfill for Antananarivo Support investments in recycling, including composting and biogas facilities	CTDs, Waste companies Work through existing support programs (e.g., PIC2)

Note: Note: Where recommendations are in green they are for implementation in the short term (1-3 years); where they are in blue they are in the medium term (3-5 years).

Table 5.6. Recommendations for Sustainable Tourism

Policy Objective	Instrument				Implementation responsibilities
	Assessment	Legal/ Regulatory Reform	Capacity Building	Investment	
Enhance tourism development planning at the national level			Enhance tourism sector planning, and improve coordination between tourism authorities and environmental authorities and MNP for planning		Ministry of Tourism, MEDD, MNP, MATSF
Improve regional destination management	Assess international best practices in destination management for similar destinations		Pilot innovative, collaborative models for integrated destination management entities for regional destinations	Invest in the implementation of regional destination management entities	Municipalities, regional tourism offices, decentralized representations of the Ministry of Tourism
Increase prevalence of "green" certifications, standards and labels			Build capacities of (groups of) tourism operators to apply environmental standards and apply for green certifications or labels	Provide financing to tourism operators to apply sustainable practices to comply with standards/ certifications	Donors, tourism private sector, Ministry of Tourism, Tourism Confederation
Improve local infrastructure and services for tourism operators				Scale-up investments in local infrastructure and services in key tourism destinations, allowing tourism operators to facilitate sustainability efforts by operators (e.g., water treatment, solid waste collection)	Municipalities, MATSF, and donor projects working on tourism, infrastructure, urban development, rural development, etc.
Facilitate access to finance for tourism operators to apply sustainable practices			Build capacity of tourism operators in sustainability practices	Provide access to finance for operators to implement sustainable practices that require capital investment (e.g., Mandrisika model)	Donors, Ministry of Tourism, MEDD

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6

CONCLUSIONS AND RECOMMENDATIONS

187. **The CEA has tried to make the case that improved management of Madagascar's natural capital is essential to the country's transition to a green, inclusive, and resilient growth path.** *It has argued for an integrated and participatory integrated landscape management approach* to land, water, and forest management which balances interventions to protect and restore ecosystem integrity, assuring delivery of natural capital services in the long term, with interventions which will improve access to local services and increase productivity in the short run. It has, similarly, made the case that policies to support the transition to more energy efficient and cleaner cooking need at the same time to support expansion of woodfuel production through plantations, agro-forestry and community woodlots in order to address one of the key drivers of deforestation, reduce indoor air pollution, and improve women's and children's health. It has made the case for an integrated Blue Economy approach to better leverage its diverse marine resources for economic development, while keeping its coastal and marine ecosystems healthy. Fisheries, aquaculture, coastal habitats, marine renewable energy, as well as other sectors of the Blue Economy still have potential to better contribute to the economy and to the livelihood of coastal communities of the fifth largest island in the world. This development should be done through an integrated approach, optimizing the development of each sector, without mutually compromising each other. It has made the case for the potential of nature-based tourism, which can help maintain protected areas and natural assets through sound management, sufficient funding and sharing the benefits with communities, while creating jobs by growing the tourism sector. It has argued that protected area managers need to work with the tourist industry to understand the market and incentivize private investment in tourist facilities. It has also emphasized the importance of developing infrastructure and services to support the tourist industry, including investments in roads and local capacity to deliver municipal services. It has highlighted the emerging challenges of ambient air pollution and solid waste management as cities grow, and argued for proactive measures, while also arguing for improved environmental management of new investments and practices to promote more environmentally sustainable tourism.

188. **Many of the solutions to improved management of natural capital and the environment are crossing-cutting and address broader capacity and governance issues.**

- *The private sector investment environment needs to be strengthened*, in particular as regards to property rights, the cost of construction permits, and delays in obtaining financing both from commercial banks and from development finance institutions. This will create a more favorable environment for investments not only in the tourism sector but in green industries more broadly.
- Improved management of natural capital and environmental pollution need *well-functioning organizations, particularly at sub-national level.* This includes capacity to plan and manage investment projects, to manage and monitor expenditures and outputs, to work at various scales, including through inter-communal cooperation and to include the interests of different groups. Technical capacity in deconcentrated sectoral organizations should be strengthened to deliver better services to decentralized organizations. In cities, municipalities need to have the capacity to deliver services in areas, such as solid waste management, sanitation, and drainage and address the growing challenge of air pollution through traffic management. In rural areas they play an enabling role in integrated landscape approaches as well as to broader rural development. At the central level there is room for greater inter-ministerial cooperation and a willingness to move forward with needed policy changes, not only in regulations but also in staffing and career policies, including in deconcentration of technical staff at the sub-national level.
- It is also important that *donor agencies cooperate to maximize development outcomes*, and that government agencies facilitate this cooperation and ensure coordination.

189. **Government is committed to improving natural capital and environmental management through the PEM.** Its policies are articulated in the policy documents referred to in the preceding chapters, including the former Tourism Policy Letter and upcoming Tourism Policy, the Strategy for Forest Landscape Restoration, the Health and Pollution Action Plan, the New Energy Policy, and the Handbook Articulating the Constitutional Requirements for the Protection of the Environment, as well as in sector-specific legislation. The next subsections provide recommendations on suggested policy, regulations, capacity building, and investment measures to restore and increase productivity of natural capital on land and along coasts and beyond, promote sustainable growth of tourism, mitigate emerging urban pollution challenges, and improve environmental management as the Government of Madagascar advances with the PEM. The full suite of recommendations for each major theme – landscape management, Blue Economy, nature-based tourism, and environmental management are included at the end of each respective chapter. This chapter highlights the priority interventions.

ADOPT INTEGRATED AND PARTICIPATORY LANDSCAPE MANAGEMENT APPROACHES

190. **Using landscape approaches helps conserve and restore the natural capital on which Madagascar depends and provides lasting benefits and long-term resilience for investments affecting land and water management and for Madagascar's citizens.**

- *Promote tenure security for forest and non-forest lands.*
- *Improve regulatory framework for community-based natural resource management.* The regulatory and institutional mechanisms for landscape approaches mostly already exist through the CTD planning mechanisms at communal and inter-communal level but there is a need for greater coordination between sectors. There needs to be greater consistency between the legislation for community-based natural resource management, the GELOSE, the forest law, and the land tenure law. This requires collaboration between MEDD and MATSF (Ministre de l'Aménagement du Territoire et des Services Fonciers), as well as with the Ministries of Agriculture and Livestock and of the Ministry of Interior and Decentralization.
- *Mainstream landscape approaches into larger scale investments.* These include investments in water resource development for hydropower

and irrigation. Maintenance of upstream watershed ecosystem functions is key to their sustainability. There is room for exploring further Payment for Ecosystem Schemes in this regard. The Strategic Environmental and Social Impact Assessment (SESA) tool, if used effectively, can also help build in maintenance of these ecosystem functions into permitting, procurement, and longer-term operations. MEDD needs to work with the relevant sector agencies and ministries to advance policies and actions in this regard (e.g., JIRAMA, the Ministry of Energy and Hydro-carbons and of Water Supply and Sanitation and of Agriculture and Livestock for water resource development, and Ministries of Transport and Meteorology and Public Works). At the same time, adapt landscape approaches to specific contexts and expand existing programs, such as PADAP and Mionjo, while exploring the scope for greater use of environmental finance instruments, such as REDD+ and PES to support investments. Existing implementing agencies would work with MEDD and development partners to explore these options, with the participation of CTDs and STDs.

- *Invest in productive forestry.* Both to reduce deforestation and to facilitate the transition to more energy efficient and cleaner cooking and improve women's health, investments in productive forestry (for woodfuel and charcoal for construction) need greater support. This includes community woodlots, trees on agricultural, land and private sector wood plantations.
- *Upscale support for the transition to more energy efficient and cleaner cooking.* There needs to be continued support for expanded use of improved fuelwood and charcoal burning cookstoves, with financial incentives to reach populations and with the private sector to expand production. Expansion in production of ethanol for use in clean cookstoves, for solar powered stoves, and for biogas also needs continued support. Implementation could be through grant mechanisms to CTDs through the next phase of an ongoing program such as Mionjo, but cooperation is also needed with private sector initiatives and the Ministry of Energy and Hydrocarbons. There is potential for exploring carbon finance to support investments.

TRANSITION TO A BLUE ECONOMY APPROACH

191. Madagascar's marine resources provide important economic and social benefits to the country and its coastal population, however, the potential for the Blue Economy to better contribute to the development of the island nation needs to be enhanced.

- *Finalize, adopt, and implement a Blue Economy strategy.* Through a consultative and collaborative process, Madagascar should finalize, adopt and start the implementation of its Blue Economy strategy. This will provide the country's vision for the integrated development of the maritime and coastal sectors, while ensuring the preservation of the ecosystems that support them. It will in particular provide ways to strengthen implementation of this integrated approach across sectors. An institutional functional review should be carried out as part of the finalization of the strategy to ensure an adequate institutional framework for the implementation, as well as monitoring and evaluation of the strategy. The strategy should include climate change considerations throughout its development, as well as gender to ensure equitable opportunities for women in the country's Blue Economy.
- *Formulate and implement Marine Spatial Plans (MSP) to guide the development of the Blue Economy as well as private sector investments.* An overarching framework should be prepared for the development of subnational MSPs at the regional level. MSP will provide a mechanism to make early policy decisions on the use of the marine space for activities of the blue sectors, avoiding conflicts by looking at the necessary trade-offs ahead of time. MSP will also provide recommendations for revisions to key marine sector policies for better alignment and implementation of Madagascar's Blue Economy strategy.
- *Improve investment climates, in particular, for emerging industries, and incentivize increase in compliance and mitigation of impacts on marine ecosystems.* The regulatory framework for investment in the sectors of the Blue Economy, including emerging sectors, should be reviewed to identified how best to lift barriers and support improved compliance within key sectors with measures mitigating impacts on the environment.

DEVELOP THE POTENTIAL OF NATURE-BASED TOURISM AND TOURISM IN PROTECTED AREAS

192. Madagascar's unique natural assets can play an increasing role in supporting jobs and economic development, provided they are managed and preserved for lasting local and global benefits.

- *The level of financing for protected area management and operations needs to be increased.* Current funding levels, at US$6 million to US$8 million annually for MNP, are about a third of those generally considered necessary for a protected area system of Madagascar's size. There is a strong case for increasing the endowment of the trust fund FAPBM, given its solid reputation for sound management and the fact that it is the most stable source of funding (it contributes about US$2.2 million annually). FABM is exploring options but direct funding from development partners and NGOs is one option. NGOs and development partners' levels of funding, currently about US$2 million, could also be increased, both through development projects and through support to operations. At present most tourists visit only six protected areas out of 123 in the system, and entry revenues (US$1.5-2 million before COVID-19) are shared with other protected areas to help meet their management costs. There is a case for MNP to review this strategy (see following section). Finally, there is a strong case for direct government funding, given the public good benefits of PAs.
- *Park management training should include training for a broader range of skills.* It has traditionally focused on protection and conservation. Education and training programs could be reassessed, with a view to increasing opportunities in areas such as tourism management, interpretation, investment promotion, marketing, and administration. Planning would be undertaken with MNP together with the tourism private sector and educational establishments. Management plans for protected areas should integrate tourism planning and actions. They could identify the required investments to meet and maintain minimum tourism standards and propose flexible upgrade plans, to be aligned with future means and needs. There should be closer collaboration between tourism professionals and protected area managers. For instance, secondment of tourism specialists or private operators to contribute to tourism development as part of protected area management is one option that could be piloted, facilitated by MNP and the Ministry of Tourism.
- *The legal framework for tourist concessions in protected areas should be finalized.* After years of efforts, finalization of the framework is expected to contribute to unlocking private investment in protected areas. The finalization could be undertaken in collaboration with MNP/MEED, the Ministry of Tourism, representatives of the tourist private sector and MATSF with the support of technical assistance and/or as part of a larger package investment program.
- *The present allocation system of tourist entry fees could be re-assessed* with a view to (i) improving transparency of the system, and (ii) exploring pathways for systematically sharing (more) revenues with local communities. The assessment would need to balance the modest resources available for operations and management with the need to increase the support of local communities to protected areas. It could be undertaken by MNP with the participation of CTDs and donor support.

TACKLE EMERGING POLLUTION CHALLENGES AND STRENGTHEN ENVIRONMENTAL MANAGEMENT

193. As Madagascar urbanizes there are opportunities to tackle emerging issues of ambient air pollution and solid waste management, including those linked to tourism, while environmental impact assessment tools can be used more proactively to ensure the sustainability and resilience of investments across sectors.

- *Madagascar should adopt overall air quality standards,* based on the interim WHO guidelines. Air quality monitoring data should be made public. Understanding the level and impact of pollution will help build ownership for policy changes. Other major cities should begin to collect air quality monitoring data.

- *Strengthen the capacity of municipalities and solid waste utilities in improved solid waste management.* This should be undertaken through broader municipal development programs or projects such as the Integrated Growth Poles Series of Projects where possible, and include support for financial sustainability as well collection, separation and disposal of solid waste, and public awareness campaigns to change behavior.
- Review current legislation and regulations and propose amendments, including introduction of the Strategic Social and Environmental Impact Assessment tool; this assessment would be undertaken by MEDD with ONE and concerned ministries. Strengthen capacity for EIA and EMP in the main sectoral ministries, especially at sub-national level, including capacity to monitor both private and public investment implementation.
- *Support tourism operators both technically and financially in selecting and implementing environmental management standards* such as ISO 14001 and applying for international "green" certifications or labels. *Replicate and/or scale up programs such as Mandrisika that support tourism operators in understanding and applying sustainability practices* through both (i) technical capacity building, and (ii) access to finance for implementation.

CONCLUSIONS

194. **Madagascar is a country rich in natural capital – it is a defining feature of the country.** This report considers the status of natural capital as the country is poised to grow and urbanize in the coming decades. Through this review, it has emerged that an integrated, landscape-level and Blue Economy approach is essential for mapping out a pathway to growth that is green, inclusive, and resilient. An integrated approach brings together consideration of the land, air, and water resources that are fundamental to the health, well-being, development, and resilience of Madagascar and its people. It includes well-managed forests, marine, and freshwater resources, cities with clean air and water that are vibrant and livable, a robust tourism industry, a productive agricultural sector, and increasingly diverse industrial value chains. It includes institutions and policies which can provide the services and policy environment to enable the transition towards this growth trajectory. By adopting this approach, Madagascar has the opportunity, as the economy recovers from the COVID-19 pandemic, to move towards a growth path that provides improved lives for its citizens in a lasting way while preserving the natural capital on which this growth depends.

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ANNEX 1.
INTEGRATED LANDSCAPE MANAGEMENT PROJECTS

PADAP aims "to increase access to improved irrigation services and agricultural inputs and strengthen the integrated management of natural resources in the selected landscapes by the local actors".

Landscapes were defined based on geography, using a watershed approach.

Five watersheds were selected, all in the northern part of Madagascar (see figure 3.3), comprising parts of four regions, 45 municipalities and targeted to benefit about 50,000 families. It is made up of land used for different purposes, such as agricultural land, pastoral land, forests, and protected areas. All included irrigated areas important for food production and were highly threatened watersheds, all had potential for economic development and for promoting biodiversity conservation in critical ecosystems. Project activities include:

- Preparation of Sustainable Landscape Management Plans (SLMPs) using spatial analysis approaches, with the assistance of consultants, together with policy notes on good practice, and institutional capacity building;[121]
- Investments and capacity building in the selected landscapes, including capacity building of decentralized and deconcentrated authorities, productive investments, including in irrigation, hillside stabilization, forest stabilization, support to farmers in new techniques, partnerships with the private sector in value chain creation, and investments in management of critical ecosystems and protected areas;
- Project management, coordination and monitoring and evaluation.

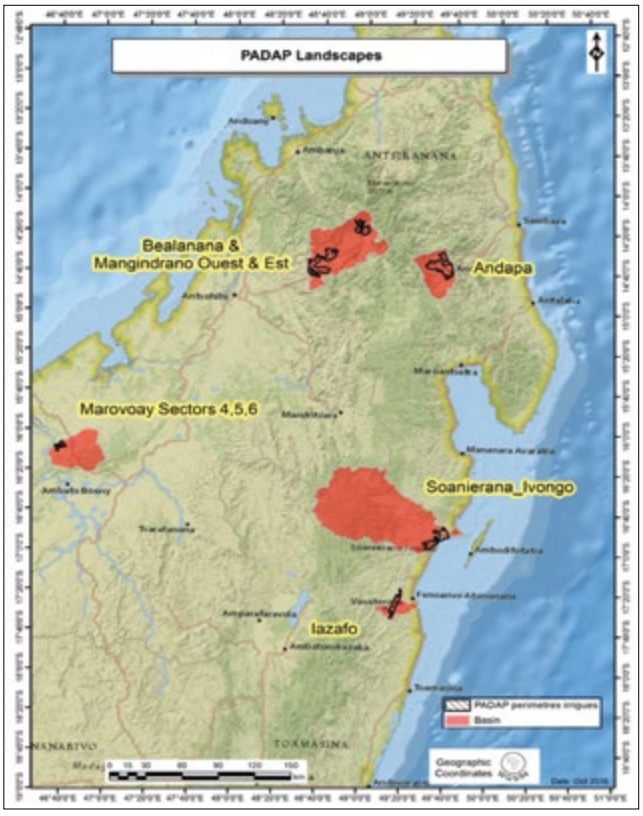
221 LAUREL, the 2016 to 2020 Land Use Planning for Resilience Project, was a US$1.9 million technical assistance project supporting the SLMP which aimed "to support integrated decision making for landscape management across sectors and levels of government in Madagascar and Mozambique" https://www.profor.info/knowledge/land-use-planning-enhanced-resilience-landscapes-madagascar-and-mozambique. It helped facilitate access to high level experts on spatial modeling and planning, and supported the development of methodological notes and development of the prototype platforms for simulating land use and land use change processes in order to support decision making. The aim was to develop the information base for planning in the different landscapes, including development of a land degradation baseline using spatial data, and a prototype land use planning decision support tool.

The Support for Resilient Livelihoods in the South of Madagascar Project (Mionjo)[222] is a 2020 to 2025 project initially financed by a US$100 million grant from the World Bank. Its objective is to improve access to basic infrastructure and livelihood opportunities and strengthen local governance in southern Madagascar, with a primary focus on youth and women. It became effective in December 2020. The three administrative regions Anosy, Androy, and Atsimo-Andrefana of southern Madagascar are drought prone and have the highest concentration of poverty in the country, with an estimated 90 percent of the population living below the poverty line. In 2021, the government articulated a strategy focused on the south, 'The Southern Regions Development Plan' ('Plan Emergence Sud Regions'). In late 2021, the project received additional financing of US$100 million[223] to strengthen the government's response to the drought, address vulnerabilities, and enhance the resilience of communities and sustainability of food production and livelihood systems to multiple risks. The additional financing document highlighted that degradation of the natural environment is one of the key driving factors as to why the drought has been so damaging in the south; ecosystem fragility has increased vulnerability to drought shocks and diminished the population's adaptive capacity.

The project has four main components:

- Strengthening local governments, including support to the Decentralized Territorial Collectivities on community-based planning, participatory planning and service delivery, and strengthening social resilience, citizen engagement, conflict prevention, and early warnings and disaster response systems;
- Support to resiliency infrastructure, including commune resiliency grants to improve access to basic services, regional water resiliency (rehabilitation and extension of water pipelines and drinking water infrastructure), and improving access to sustainable and multi-use water sources;
- Support to resilient livelihoods, including support for community-based organizations and local value chains, rehabilitation of irrigation schemes for resilient livelihoods, restoring food production capacity and strengthening resilience of food and livelihoods systems, including through locust control and climate smart agriculture; and capacity building for local government. Under the additional financing a new sub-component was added focusing on support to environment and green infrastructure including fixing dunes and wind breaks to protect fields, adaptive vegetation, and restoration of natural forests (for wood energy, livelihoods, upstream protection of water sources, and agroforestry and mangrove restoration) in the southern part of Madagascar. Forest and mangrove restoration maintains and expands ecological functions, protects the upstream ecosystems (a key target area under the pipeline project), and secures the breeding ground for fisheries resources; and reforestation satisfies local fuelwood and wood energy needs;
- Implementation support and learning, including project implementation and development of a geospatial knowledge platform, preparatory studies for SOP 2m and support for crisis response to equip the National Office of Risk and Disaster Management with resources and capacity, and institutional support to the regions, communes, and local consultation structure.

Figure A1.1. Location of the Five PADAP Landscapes

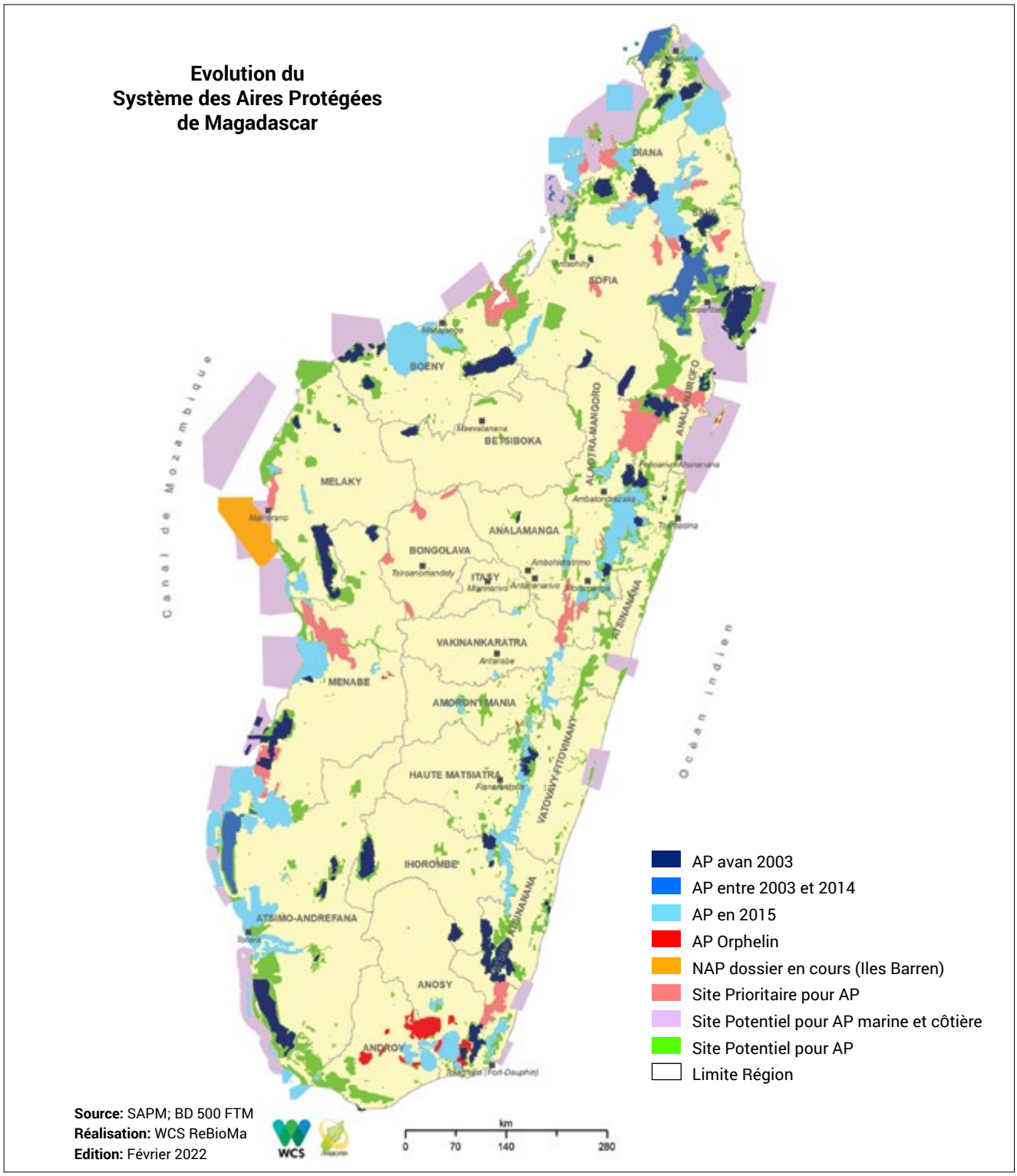


FP026: Sustainable Landscapes in Eastern Madagascar[224] Start: 01/01/2017 End: 12/31/2026

222. https://projects.worldbank.org/en/projects-operations/project-detail/P171056
223. https://documents1.worldbank.org/curated/en/937121641925820458/pdf/Madagascar-Support-for-Resilient-Livelihoods-in-the-South-of-Madagascar-Project
222. Projet de Résilience Climatique pour la Préservation de la Biodiversité

ANNEX 2.
MAP AND LIST OF MADAGASCAR'S PROTECTED AREAS

Figure A2.1. Map of Madagascar's Protected Areas



Source: SAPM, 2022.

Table A2.1. Number and Area of Protected Areas in Madagascar

	All SAPM		MNP Network		Non-MNP Network	
	No. Sites	Area (ha)	No. Sites	Area (ha)	No. Sites	Area (ha)
Cat I	1	2228	1	2228		
Cat II	28	2,617,847	27	2,245,377	1	372,470
Cat III	2	4807			2	4807
Cat IV	23 (3)	408,231.9 (53,470)	22 (3)	407,461.9 (53,470)	1	770
Cat V	39	2,617,638.4			39	2,617,638.4
Cat VI	17	865,549.5			17	865,549.5
No category	12 (10)	566,224 (484,517)			12 (10)	566,224 (484,517)
Total	**112 (13)**	**7,082,525.8 (537,987)**	**50 (3)**	**2,655,066.9 (53,470)**	**72 (10)**	**4,427,458.9 (484,517)**

Source: Gardner et al., 2018.[225]

Table A2.2. Madagascar and IUCN Protected Area Categories, Objectives and Resource Use

Madagascar category	IUCN category	Primary goal	Use of resources and tourism
Strict Nature Reserve	I – Strict Nature Reserve	Strict biodiversity or geo-heritage protection	Access and use of natural resources are forbidden, except for scientific research and very specific ritual uses
National Park or Natural Park	II – National Park	Protection of an ecosystem and its large-scale ecological processes	Harvesting of trees, animals, or plants is forbidden. Ecotourism is one of the objectives and is regulated by each management plan (no general limitation)
Natural Monument	III – Natural Monument	Conservation of specific natural features	Are forbidden any intervention susceptible to transform the ecosystems or landscapes, and any commercial harvesting of natural resources. Tourism development is an objective (no general limitation)
Special Reserve	IV – Habitat/ Species Management Area	Conservation through management intervention	Commercial use of hunting, fishing, corals, animal, and timber products is regulated. Ecotourism is authorized (no general limitation)
Protected Harmonious Landscape	V – Protected Landscape/ Seascape	Landscape/seascape conservation	The harvesting of renewable and non-renewable natural resources is regulated. Tourism activities are encouraged (no general limitation)
Natural Resource Reserve	VI – Managed Resource Protected Area	Sustainable use of natural ecosystems	Fire and deforestation are forbidden. Harvesting of natural resources is regulated. Tourism activities are encouraged (no general limitation)

Source: IUCN Protected Area Categories

225 Numbers as of 2017. Numbers in brackets refer to protected areas that currently lack active management and are considered 'paper parks'.

Table A2.3. Revenues from Tourist Fees to Protected Areas

Protected area	Category	Terrestrial /Marine	No. visitors (2017-2019 average)	Entry fees collected (US$, 2017-2019 average)
Nosy Tanikely	II	Mixed	44,567	$ 200,735
Isalo	II	Terrestrial	34,696	$ 431,397
Andasibe - Analamazaotra	II-II	Terrestrial	33,689	$ 177,111
Ranomafana	II	Terrestrial	25,579	$ 226,831
Bemaraha	II	Terrestrial	19,667	$ 123,215
Montagne d`Ambre	II	Terrestrial	14,081	$ 69,769
Ankarana	IV	Terrestrial	8,518	$ 64,047
Lokobe	II	Mixed	6,283	$ 11,850
Zom bitse	II	Terrestrial	4,692	$ 36,036
Ankarafantsika	II	Terrestrial	4,488	$ 41,531
Masoala	II	Mixed	3,823	$ 44,658
Andringitra	II	Terrestrial	2,313	$ 25,062
Tsimanampesotse	II	Terrestrial	1,441	$ 14,251
Marojejy	II	Terrestrial	1,193	$ 4,973
Nosy Hara	II	Marine	1,044	$ 18,999
Kirindy Mitea - Andranomena	II - IV	Mixed	550	$ 4,854
Cap Ste Marie	IV	Terrestrial	485	$ 1,464
Andohahela	II	Terrestrial	280	$ 4,195
Baie de Baly	II	Mixed	122	$ 1,133
Ambohitantely	IV	Terrestrial	115	$ 511
Andranomena	IV	Terrestrial	96	$ 4,854
Zahamena	II	Terrestrial	63	$ 491
Sahamalaza	II	Mixed	61	$ 820
Manombo	IV	Terrestrial	52	$ 381
Mananara-Nord	II	Mixed	40	$ 399
Beza Mahafaly	IV	Terrestrial	31	$ 199
Mikea	II	Terrestrial	22	$ 41
Manongarivo	IV	Terrestrial	13	$ 139
Analamerana	IV	Terrestrial	2	$ 25
Marolambo	II	Terrestrial	-	$ 25
Total			**208,004**	**$ 1,509,998**

Source: Numbers provided by MNP. Amounts in Ariary were changed to US$ using the yearly World Bank data rate.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ANNEX 3.
LAWS, DECREES, AND ORDERS ON POLLUTION AND SOLID WASTE MANAGEMENT

1. Law No. 98-029 of January 20, 1999 on the **Water Code.**
2. Law No. 99-021 of August 30, 1999 on management and control of **industrial pollution** policy.
3. Law No. 2001-013 of September 11, 2001 authorizing the ratification of the 1992 International Convention establishing an International **Fund for Compensation for Damage Due to Oil Pollution** (IOPC Funds). Law No. 2001-012 of September 11, 2001 authorizing the ratification of the 1992 International Convention on **Civil Liability for Oil Pollution Damage** (CLC). Law No. 2001-011 of September 11, 2001 authorizing the ratification of the 1990 International Convention on Oil Pollution Preparedness, Response and Cooperation (OPRC 90 Convention).
4. Law No. 2004-019 of August 19, 2004 implementing international conventions relating to the protection of the **marine and coastal environment against pollution by oil spills.**
5. Law No. 2005-004 of August 3, 2005 authorizing the ratification of the Stockholm Convention on **Persistent Organic Pollutants**.
6. Law No. 2011-002 of July 15, 2011 on the **Health Code**.
7. Law No. 2014-023 of December 10, 2014 authorizing the ratification of the 2001 International Convention on Civil Liability for Damage Due to **Pollution by Bunker Hydrocarbons** ("Bunker Hydrocarbons" Convention), adopted in London on March 23 2001.
8. Law No. 2014-027 of December 10, 2014 authorizing the ratification of the 2000 Protocol on the preparation, response and cooperation against pollution incidents by **Harmful and Potentially Dangerous Substances** (OPRC-HNS 2000), adopted in London on 15 March 2000.
9. Law 2014-020 of September 27, 2014 on the resources of **Decentralized Territorial Collectivities,** election procedures, and the organization, operation and powers of their bodies, as amended by Law No. 2015-008 of March 20, 2015.
10. Law No. 2015-003 of February 19, 2015 on the updated Malagasy **Environmental Charter.**

11. Law No. 2016-048 of December 16, 2016 authorizing Madagascar's accession to the 1996 Protocol to the 1972 Convention on the Prevention of **Marine Pollution** Resulting from the Dumping of Waste (London Protocol 1996).
12. Law No. 2017-037 of January 15, 2018 authorizing Madagascar's accession to the 1997 Protocol to the International Convention for the Prevention of **Pollution from Ships** of 1973, as amended by the 1978 Protocol relating thereto (1997 MARPOL Protocol).
13. Decree No. 2001-898 of October 11, 2001 ratifying the 1992 international convention establishing an International **Fund for Compensation for Damage Due to Hydrocarbon Pollution** (IOPC Funds); Decree No. 2001-897 of October 11, 2001 ratifying the 1992 international convention on **civil liability for damage due to pollution by hydrocarbons;** Decree No. 2001-896 of October 11, 2001 ratifying the 1990 International Convention on Oil Pollution Preparedness, Response and Cooperation (OPRC 90 Convention).
14. Decree No. 2002-1274 of October 16, 2002 establishing the general principles of radioactive waste management; Decree No. 2002-1199 of October 7, 2002 establishing the general principles of protection against ionizing radiation; Decree No. 2002-1161 of October 2, 2002 laying down the general principles governing the possession and use of ionizing radiation sources intended for medical or odonto-stomatological purposes.
15. Decree No. 2003-439 of March 27, 2003 establishing an **environmental unit within each ministry**.
16. Decree No. 2002-569 of July 4, 2003 setting the powers and operation of the various bodies responsible for protection against the dangers of ionizing radiation and the management of radioactive waste in Madagascar.
17. Decree No. 2004-1018 of November 9, 2004 ratifying the 1973 International Convention for the Prevention of Pollution from Ships (Marpol 73/78 and its annexes).
18. Decree No. 2004-994 of October 26, 2004 on the creation, organization, and operation of the Hydrocarbons Marine Pollution Incident Response Body (**OLEP**, *Organe de Lutte contre l'Evènement de Pollution marine) by hydrocarbons*.
19. Decree No. 2004-167 of February 3, 2004 relating to the **compatibility of investments with the environment** (MECIE).
20. Decree No. 2005-512 of October 24, 2005 ratifying the **Stockholm Convention on Persistent Organic Pollutants.**
21. Decree No. 2006-680 of September 12, 2006 adopting the National Policy for the Management of Healthcare Waste and Injection Safety.
22. Decree No. 2007-327 of April 27, 2007 repealing Decree No. 2003-170 of March 4, 2003 on the regulation of the import and use of substances that deplete the **Ozone layer;** and regulating the import, sale, resale and use of refrigerants, refrigeration appliances or equipment and halons.
23. Decree No. 2008-600 of June 23rd, 2008 and amended by Decree No. 2019-1393 of July 17, 2019 creating the National Office for the Environment (**ONE**, Office National pour l'Environnement).
24. Decree No. 2011-627 of October 11, 2011 defining a national policy for the **use of dispersants in the maritime waters** of Madagascar.
25. Decree No. 2011-449 of August 9, 2011 creating a public establishment of an industrial and commercial nature responsible for the management of solid waste in the urban municipality of Nosy Be and called the Waste Management Establishment in Nosy Be "EDEN".
26. Decree No. 2012-1113 of December 4, 2012 suspending the export of scrap metal, aluminum waste, copper waste and, exceptionally authorizing certain companies to send their goods; Decree No. 2012-900 of October 9, 2012 prohibiting the import, distribution, sale, use and production of certain active ingredients pesticides in agriculture and chemicals in the industrial sector under the application of the Rotterdam Convention and the Stockholm Convention.
27. Decree No. 2012-754 of August 7, 2012 setting the procedures for the management of end-of-life products, sources of waste and hazardous waste harmful to the environment within the framework of the implementation of the Basel Convention; Decree No. 2012-753 of August 7, 2012 prohibiting the import of waste under the Basel Convention in Madagascar until the installation of adequate treatment centers.

28. Decree No. 2013-428 of June 13, 2013 suspending the purchase and sale of scrap metal, aluminum and copper waste.
29. Decree No. 2014-052 of January 21, 2014 amending and supplementing the appendix to Decree No. 2012-1113 of December 4, 2012 suspending the export of scrap metal, aluminum waste, copper waste and, authorizing exceptionally certain companies to send their goods.
30. Decree No. 2015-930 of June 9, 2015 on the classification and environmentally sound **management of waste from electronic and electrical equipment** (WEEE) in Madagascar.
31. Decree No. 2015-857 of May 12, 2015 ratifying the 2000 Protocol on Preparedness, Response and Cooperation against Pollution Incidents by **Harmful and Potentially Hazardous Substances** (OPRC-hns 2000), adopted in London on March 15, 2000.
32. Decree No. 2015-856 of May 12, 2015 ratifying the 2001 International Convention on **Civil Liability for Damage Due to Pollution by Bunker Hydrocarbons,** adopted in London on March 23, 2001.
33. Decree No. 2017-920 of October 10, 2017 publishing resolution A.741(18) relating to the adoption of the "international management code for the **safe operation of ships and pollution prevention**" as amended or "ISM code", adopted on November 4, 1993 by the International Maritime Organization.
34. Decree No. 2017-233 of April 5, 2017 on Madagascar's accession to the 1996 protocol to the 1972 Convention on the **prevention of pollution of the seas** resulting from the dumping of waste (London Protocol 1996).
35. Decree No. 2017-622 of July 25, 2017 authorizing the marketing on the national market of **biofuel** from the treatment and **recovery of household waste.**
36. Decree No. 2018-393 of May 2, 2018 on the accession of Madagascar to the 1997 Protocol to the International Convention for the **Prevention of Pollution by Ships** of 1973, as amended by the 1978 Protocol relating thereto (1997 MARPOL Protocol)
37. Decree No. 2018-1145 of September 5, 2018 **prohibiting the import and regulating the export** of waste, hazardous waste, hazardous substances and materials containing them in Madagascar.
38. Interministerial Order No. 6941/2000 of July 5, 2000 fixing the smoke emissions relating to the **exhaust gases of motor vehicles.**
39. Order No. 12032/2000 of November 6, 2000 on the regulation of the **mining sector** in terms of environmental protection.
40. Order No. 6830/2001 of June 28, 2001 setting the terms and procedures for **public participation in environmental assessment.**
41. Order No. 12890/2007 of August 3, 2007 establishing a National Committee for the Implementation of the Basel Convention (on the control of transboundary movements of **hazardous waste and their disposal)** and the ecological and rational management of heavy metals.
42. Order No. 723/2012 of February 27, 2012 establishing a National Office and a National Synergy Committee between the Basel Convention, the Stockholm Convention and the Rotterdam Convention on waste and chemicals.
43. Order No. 36802/2013/MEEMF of December 30, 2013 establishing the National Committee for the Implementation of the Minamata Convention on **Mercury** in Madagascar.
44. Order No. 28831/2013 of September 24, 2013 setting the list of products prohibited by Decree No. 2012-900 of October 9, 2012 prohibiting the import, distribution, sale, use and production of certain active ingredients pesticides in agriculture and chemicals in the industrial sector under the application of the Rotterdam Convention and the Stockholm Convention.
45. Order No. 9007/2018 of April 13, 2018 relating to the "National Policy for the Management of Medical Waste and the Safety of Injections in Madagascar.

Photo credit : Mamy Razafindrakoto

ANNEX 4.
MADAGASCAR INTEGRATED LANDSCAPE ASSESSMENT METHODOLOGY SUPPLEMENT

1. STUDY OBJECTIVES

The objectives of the current study are to:

- Create a spatially explicit, data driven assessment of land degradation in Madagascar over the last 30 years;
- Evaluate the impacts of land degradation on ecosystem services to key sectors, including erosion control for agricultural productivity, water, and sediment regulation for hydropower production, and carbon storage;
- Evaluate the potential for investments in landscape management that improve vegetation cover to effectively offset landscape degradation and improve ecosystem services values to key sectors; and
- Identify priority areas for investment in NBS based on their potential contribution to improving ecosystem services and landscape productivity.

The overall methodology comprised the following steps, which are detailed in the sections below:

1. Using data on physical conditions (topography, soils) along with historical data on land-use, land cover, rainfall, deforestation, and remote sensing-based ecosystem indicators, **perform a trends analysis** to identify areas of where erosion and ecosystem health indicators are in decline, and where they show recovery.
2. Combine information on land degradation and land-use change with publicly available economic information to **estimate the economic impact of land degradation,** focusing on the agriculture, hydropower generation, and carbon emissions sectors.
3. Apply spatially explicit ecosystem services models to **evaluate the potential impact of investments in improved land management** (ILM) on baseflow, storm runoff, and erosion.

4. Apply the models developed in Step 2 to **estimate the potential savings to key sectors** that could result from these investments.

2. TREND ANALYSIS OF LAND DEGRADATION

A composite land degradation index was developed based on pixel-level analysis of historical trends in four sub-indicators: vegetation health condition, carbon storage, soil retention, and baseflow contribution. These sub-indicators were selected based on FAO's Global Land Degradation Information System (GLADIS) method, which emphasizes an assessment of the status and trends of ecosystem goods and services, including the impacts that changes have on local populations.[1,2] The selected indicators rely on remote sensing data and are known to provide meaningful proxies of land degradation in terms of severity, temporal dynamics, and areal extent.[3]

Selected sub-indicators for the composite land degradation index:[4]

- **Vegetation health condition:** The Normalized Difference Vegetation Index derived from Landsat data (NDVI; 30m resolution) was used as a proxy for vegetation health. NDVI provides valuable information about temporal and spatial changes in vegetation distribution, productivity, and dynamics, allowing monitoring of habitat degradation and fragmentation, or assessment of the ecological effects of climatic disasters such as drought or fire.[5]

- **Carbon storage:** MODIS-derived Net primary productivity (NPP; 500m resolution) was used as a proxy for carbon storage. NPP data indicates inter-annual variations in net biomass (carbon) gain by vegetation over year-by-year. Changes in this indicator also point to how the landscape has changed in terms of the availability of food, biofuel, and fodder over time,[6] and has been used as a measure of agricultural sustainability.[7]

- **Soil retention services:** The InVEST Sediment Delivery Ratio model v3.9[8] was used to model soil retention for this indicator (90m resolution). The model output represents the capacity of a landscape to retain sediment by using information on geomorphology, climate, vegetative cover, and management practices such as anti-erosive techniques available in the landscape.

- **Water availability via baseflow:** Baseflow refers to water slowly released as surface water from local recharge of soil moisture and aquifers.[9] Baseflow was modeled using the InVEST Seasonal Water Yield Model v3.9.30 Baseflow is mainly driven by precipitation and evapotranspiration and vegetation cover management present in the landscape.[10]

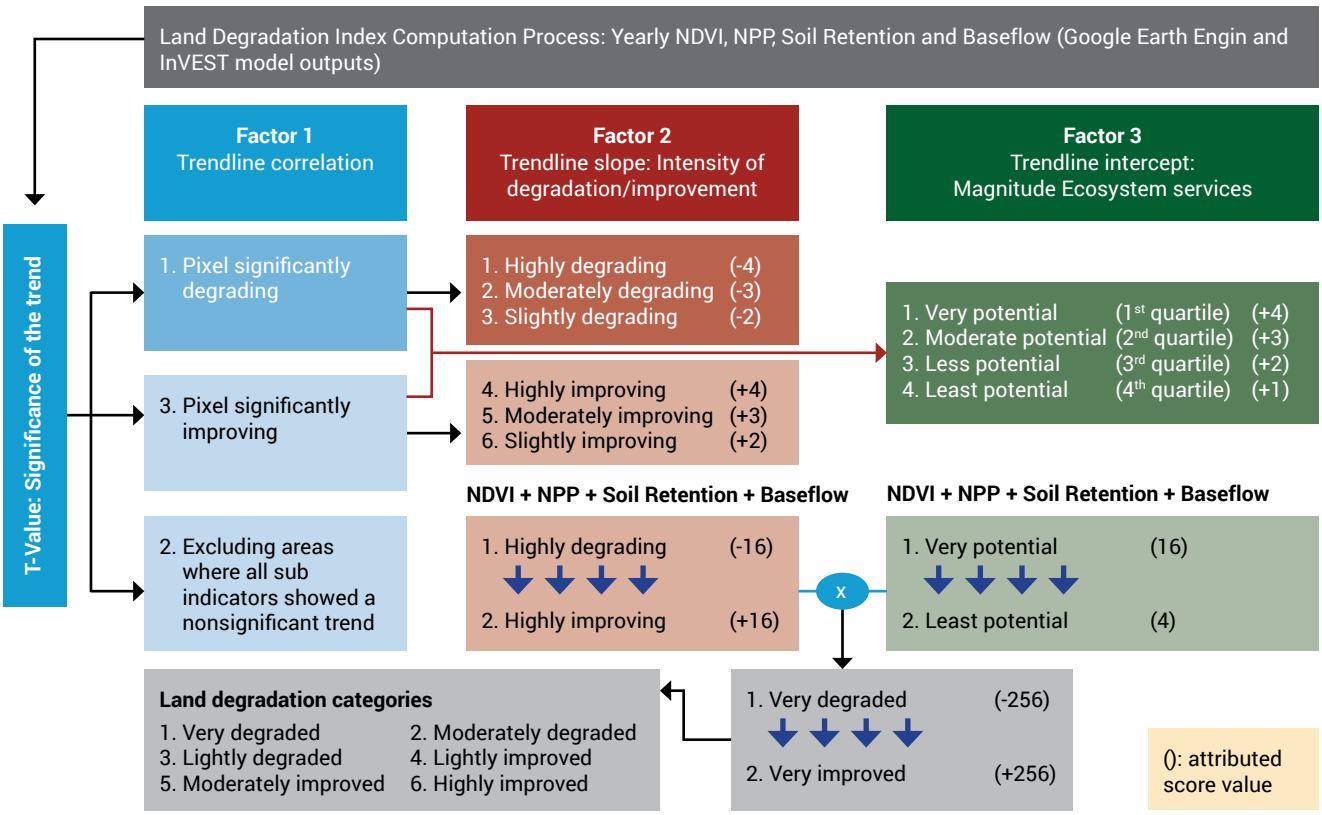
The final Land Degradation composite index was calculated by combining the four sub-indicators as described in Figure 1. The land degradation index was supplemented with an analysis of deforestation and changes in precipitation over the same time period, to explore their linkages to land degradation. We also report on human population change, livestock density, and deforestation and land degradation within a 500-meter buffer zone of riverbanks.

1.1. Data processing

The vegetation health indicator utilized the Normalized Difference Vegetation Index (NDVI) derived from Landsat imagery at 30-meter resolution, available from 1992 to 2020. Net Primary Productivity (NPP) at 500m resolution was obtained from MOD17A3HGF V6,[11] for the years 2000 to 2018. Five-year moving averages of NDVI were calculated to account for the fact that inter- and intra-annual variability of external factors can affect the values of these parameters year-to-year (for example, fallow periods that range from three to five years in Madagascar,[12] slash-and-burn agriculture (tavy), seasonality and plant phenology, etc.).[13,14] For example, the NDVI values estimated for 1992 were the average NDVI based on all imagery recorded from 1990 to 1994, then NDVI for 1993 were the averages from imagery recorded from 1991 to 1995. The same moving window averaging was applied to NPP data. Historical series of NDVI were corrected to account for differences in sensor specifications between Landsat 5, Landsat 7, Landsat 8. The NDVI transformation equation for intercalibration of vegetation indices from different sensor systems was applied, based on studies of Steven et al.[15] for Landsat 5 to 7, then Roy et al.[16] for Landsat 7 to 8.

The analysis of soil retention and baseflow utilized the InVEST Sediment Delivery Ratio (SDR) model and Seasonal Water Yield (SWY) models, v3.9. InVEST is a widely used tool for ecosystem services modeling, and has been tested in high or poor data environments with promising results.[17,18] The spatially explicit SDR model estimates for each pixel the average amount

Figure A4.1. Madagascar Land Degradation Index based on Historical Trends from 1992 to 2020



of erosion per year, then integrates information on the landscape context (land cover and land-use upslope and downslope of the pixel) to estimate the amount of sediment thereafter retained on the landscape washed away in streams. The model is based on an implementation of the Revised Universal Soil Loss Equation (RUSLE1)46 for the calculation of annual soil loss, and a sediment delivery function driven by the hydrological connectivity of each pixel within the landscape. Once sediment reaches the stream, the model assumes that it ends up at the catchment outlet, thus no in-stream sediment deposition or remobilization processes are modeled.[19]

The seasonal water yield (SWY) model allows users to rank specific parcels (or pixels) of land for conservation or development based on their relative contributions to specific components of the hydrological cycle. The model partitions precipitation into either quick flow or base flow (runoff versus groundwater recharge) by calculating a water balance for each individual pixel of the watershed of interest. The information required by the SWY model is easily obtained globally from publicly available data sources and includes monthly precipitation, topography, evapotranspiration, land-use, soil type, and land cover data.[20]

The required input data for the SDR and SWY models include topography (digital elevation model, or DEM), soil characteristics (erodibility and hydrologic soil group), monthly mean rainfall, monthly mean reference evapotranspiration, and various physically-based parameters that reflect how vegetation cover and condition affect the impact of rainfall on erosion and the partitioning of rainfall inputs into runoff, infiltration, and baseflow. See Section 5 for a full listing of data requirements and sources.

A key input is the land use land cover (LULC) map. Because an official national land cover map does not exist that satisfies the historical criteria for the study, the European Spatial Agency (ESA) Climate Change Initiative (CCI) land cover map at 300m resolution was used. This map is available on a yearly basis since 1992.[21,22] The Copernicus Global Land Service: Land Cover (CGLOPS; 100m resolution) and the recently released 10m resolution land cover map by ESA23 were considered but rejected because they were not available over the historical time period, despite their high spatial resolution. The 38 native classes in the ESA CCI LULC maps were reclassified to align with the 11 classes of ESA[23] to allow compatibility of future LULC developed by Madagascar Land Use Planning for

Enhanced Resilience of Landscapes (LAUREL) project completed in July 202024 and 10-m resolution global map class.

Precipitation and reference evapotranspiration were taken from the Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS).[25,26] Rainfall erosivity was taken from Panagos et al. (2017), who estimated global erosivity based on extensive field-based data from 3,625 stations observed for 16.8 years.[27] Soil erodibility (K) values were based on Africa soil typology from Hengl et al. (2021) at 30m resolution, which provides fractions of silt, fine sand, clay, organic content, and bulk density parameters.[28] K values were calculated according to the EPIC model methodology (Equation 2)[29,30] and converted into international units by multiplying by 0.1317.31

$$K_{epic} = \left[0.2+03 \exp\left(-0.02556 \text{ x } San \frac{1\text{-}Sil}{100}\right)\right] \text{x } \left(\frac{Sil}{Cly + Sil}\right)^{0.3}$$

$$\text{x } \left(1\text{-} \frac{0.25C}{C + \exp(3.72 - 2.95C)}\right) \text{ x } \left(1\text{-} \frac{0.7SNi}{SNi + \exp(-5.51 + 22.9SNi)}\right)$$

(Equation 2)

where

San : sand content (%)

Sil : silt content (%)

Cly : clay content (%)

C : soil organic carbon content (%)

Other parameter inputs to the models were guided by local studies and regional studies whenever available (see model parameter values in Section 6). The SDR and SWY models were run yearly from 1992 until 2020, and the resulting output rasters for soil retention (*sed_retention,* tons/ha/yr) and baseflow (B, mm/yr) were used in the subsequent trend analysis.

Deforestation between 2000 and 2020 was analyzed based on yearly forest cover from 2000 to 2018 developed by The United States Forest Service (USFS) in partnership with Madagascar Bureau National des Changements Climatiques, et de la REDD+(BNCCREDD+).[226] The original data classified forest into four major classes: humid forest, dry forest, mangrove, and thorny forest, and those classes were combined to estimate forest coverage. To explore deforestation, and to control for inter-annual forest dynamics and potential discrepancies in forest classification year-to-year, we subtracted the forest cover of 2018 from the area that has ever been classified as forest between 2000 and 2017 to obtain the total area deforested.

1.2. Trend analysis: Slope, magnitude, and change significance

For each of the four indicators plus precipitation, a trend analysis using pixel-based linear regression was performed using the processed time series (data and/or model results). The resulting slope of the regression indicates the annual increment of the indicator (either positive or negative), while the regression intercept value indicates the magnitude of the specified indicator.

The slope, which represents the time variation characteristics of variables, was determined by using ordinary least squares regression pixel-by-pixel using Equation 3.[32,33] The slope is expressed as follows:

$$\theta slope = \frac{n\sum_{i=1}^{n} i \text{ x } fc_1 - \left(\sum_{i=1}^{n} i\right)\left(\sum_{i=1}^{n} fc_1\right)}{n \text{ x } \sum_{i=1}^{n} i^2 - \left(\sum_{i=1}^{n} i\right)^2}$$

(Equation 3)

where

n : number of years studied

i : year

θ : regression slope

The indicator's magnitude was calculated as the trendline intercept as shown in Equation 4:

$$A = \bar{y} - \theta \bar{x} \qquad \text{(Equation 4)}$$

where

A is the intercept

$\bar{y}$ represents the mean value of NDVI ,NPP, precipitation, soil retention or baseflow volume

θ is the trendline slope

Estimated trends that were significant at the 95 percent confidence level (based on T-values) were used to classify the pixels into degrading or improving, and those that were not significant were classified as no change or no trend. The correlation coefficient was used to calculate the T value (T-test),[34,35] and the T-distribution table was used to reclassify the T-value at 95 percent confidence interval in relation to the degree of freedom of each indicator. The correlation was calculated by pixel-by-pixel correlation analysis, using equation 5.[32,33]

226 Data were acquired from World Bank Madagascar team. Data are not published and not officially validated by the Government of Madagascar.

$$r_{xy} = \frac{\sum_{i=1}^{n} [(x_i - \bar{X})(y_i - \bar{Y})]}{\sqrt{\sum_{i=1}^{n} [(x_i - \mathrm{X})^2 (\sum_{i=1}^{n} i (y_i - \mathrm{Y})]^2}}$$

(Equation 5)

where

n : number of years studied

x: mean value of the independent variable x

$\bar{Y}$: mean value of NDVI, NPP, precipitation, soil retention or baseflow volume

r_xy : correlation coefficient between the variables x and y

The T-value was calculated using equation 6.

$$T = R\sqrt{\frac{n-2}{1-R^2}}$$

(Equation 6)

where

T : t-value

R : correlation

n : number of years studied

1.3. Land degradation composite index

The land degradation composite index was calculated as a weighted index developed through three stages. The first stage excluded any pixels where all four sub-indicators showed no trend over the study period. The second stage considered the annual increment (e.g., slope of the regression) for each sub-indicator. The increment was classified into one of six classes and pixels in each class were assigned the corresponding score: highly degrading (-4), moderately degrading (-3), slightly degrading (-2), slightly improving (+2), moderately improving (+3), and highly improving (+4). Pixel-level scores for the four sub-indicators were summed. For example, if a pixel showed moderate degradation in NPP (-3) but showed a high improvement in baseflow (+4), this led to a positive score (+1), implying an overall positive trend between the two sub-indicators. The third stage accounted for the magnitude (or the potentiality) of the services, indicating the area where a small change could have a high impact. For example, the soil retention service has a high magnitude in steeply sloping regions where there is also high precipitation. Thus, any proportional change on that high magnitude pixel would lead to a high impact relative to a low magnitude pixel, even though the proportional change might be the same. The magnitude value was represented by the intercept of the regression trendline. The magnitude was similarly classified into four scores based on quartiles, and then all four sub-indicator magnitude scores were combined in an additive approach.

The final land degradation composite index is the product of the final increment (slope) and magnitude scores, and was reclassified into six classes (three degrading and three improving; refer to Figure 3).

3. ESTIMATING ECONOMIC IMPACTS OF LAND DEGRADATION

Information on net primary productivity (carbon storage) and erosion generated by the above analysis was processed to estimate the economic impact of land degradation for Madagascar. Key sectors were analyzed with multiple economic valuation methods, including agriculture, hydropower generation, and carbon emissions, at the National level and for the 29-year period between 1992 and 2020.

3.1. Carbon

i. Carbon stock losses

Land use change and land degradation result in the release of carbon stock due to deforestation and a decrease in the capacity of all ecosystems to absorb carbon from the atmosphere through photosynthesis.

The release of carbon stocks from diminishing forest covers has an opportunity cost for society, as it can no longer access funds from carbon credits in the cleared areas. Carbon credits are traded in different markets around the world, with US$45 billion raised in carbon pricing revenues globally in 2019 (World Bank, 2020).[227] Madagascar is not a stranger to this revenue source, for example with the Atiala Atsinanana Emission Reduction Program, Madagascar, that sets a price of US$5 per ton of CO2e as reference (FCPP,2018).[228] This potential market price and the carbon content of Madagascar's forests can be used to estimate the potential income loss by Madagascar due to land use change.

227 World Bank Group. 2020. State and trends of carbon pricing 2020.

228. Forest Carbon Partnership Facility. 2018. ER Program Name and Country: Atiala Atsinanana Emission Reduction Program, Madagascar

We used Vieilledent et al. (2018) data on forest loss from 1992 to 2010, and data reported by Forestwatch (2021) for 2011 to 2020. The humid forest category was selected because most REDD+ projects are located in this type of ecosystem. Carbon stock release was estimated from two different sources[229] that were used as two different scenarios for the valuation. The final value reported was the average of the two scenarios. Both national level estimates as well as specific losses in Protected Areas were calculated, due to the importance of these critical zones. The value of potential carbon credits lost was calculated based on the following formula:

$$C = P * (A * S) \quad \text{(Equation 7)}$$

where

C: Opportunity cost of lost carbon credits

P: Market price of CO2, measured in $ per ton of CO2

A: Total area of deforestation, measured in ha

S: CO2 content of forest, measured in tons of CO2 per ha

ii. Carbon absorption losses

The decreasing capacity of ecosystems to absorb carbon implies that significant amounts of this greenhouse gas are left in the atmosphere instead of being incorporated and transformed to biomass. The year to year changes in NPP were calculated in Section 1. The average amount of carbon not absorbed during the analysis period was 1.56 M tons of CO2 per year. Besides the potential carbon credits, an alternative approach to measure this impact is through the social cost of carbon. This cost of carbon incorporates the indirect negative effects of carbon emissions at a global level and into the future (Hockley & Razafindralambo, 2006).[230] Nordhaus (2017)[231] estimates that the social cost of carbon was US$38.1 per ton of CO2 in 2015. This reference value was updated to 2020 USD of the specific years of the study period based on Nordhaus' (2007) recommendations, considering global growth rates as well as a three percent increase in value from year to year. Applying the social cost of carbon to the amount of CO2 not absorbed due to land degradation allows its valuation with the following formula:

$$C = \sum N_t \, x \, S_t \quad \text{(Equation 8)}$$

where

C: Global cost of carbon not absorbed

N: NPP decrease in period t, measured in tons of CO2 at the National level

S: Social cost of carbon price for period t, measured in 2020 US$ per ton of CO2

3.2. Hydropower

i. Hydropower generation

The impact of sedimentation and reducing water yields in the three main hydropower plants of Madagascar (Andakaleka, Antelomita and Mandraka, that provide nearly 90 percent of the generation in the Antananarivo Interconnected Network) was calculated based on the work by Adeogun et al.(2016)[232]. These authors explain the difference between the installed generation capacity and the actual generation based on multiple factors and determine that suboptimal hydrological provision accounts for 19 percent of generation losses.

Based on this coefficient, the historical generation of electricity and the tariffs for electricity[233], it was possible to estimate how much less reliable water is costing the hydropower sector. The following formulas detail the estimation process:

$$HPL = ICG\text{-}HPG_t \quad \text{(Equation 9)}$$

$$C = \sum_{t=1}^{n} HPL_t \, . \, WMD \, . \, P_t \quad \text{(Equation 10)}$$

where

HPL: hydropower production loss, measured in kWh

ICG: Installed capacity hydropower generation, measured in kWh

229. Razafindralambo, R. Quoted on Hockey & Razafindralambo. 2006. A Social Cost-Benefit Analysis of Conserving the Ranomafana-Andringitra-Pic d'Ivohibe Corridor; and van Kooten, G.C., Eagle, A.J., Manley, J., & Smolak, T. 2004. How costly are carbon offsets? A meta-analysis of carbon forest sinks. Environmental Science & Policy, 7, 239-251.

230. Hockley, N. & Razafindralambo, R. 2006. A Social Cost-Benefit Analysis of Conserving the Ranomafana-Andringitra-Pic d'Ivohibe Corridor

231. Nordhaus, W. D. 2017. Revisiting the social cost of carbon. Proceedings of the National Academy of Sciences, 114(7), 1518-1523.

232. Adeogun, Niyi & Sule, B. & Salami, Adebayo. 2016. Cost effectiveness of sediment management strategies for mitigation of sedimentation at Jebba Hydropower reservoir, Nigeria. Journal of King Saud University - Engineering Sciences. 30. 10.1016/j.jksues.2016.01.003

233. The data source was the Office de Régulation de L'électricité Madagascar. 1) Inventaire du parc hydroélectrique existant Juin 2013, RI Antananarivo (RIA) ; 2) Données Techniques, Statistiques de Ventes, Abonnés et Productions JIRAMA

Table A4.1. Weighted Matrix for Factors Related to Loss in Hydropower Production

Task	Mechanical	Hydrological	Electrical	Civil	Maintenance	Sediments	Others
Ranking	1	2	3	4	5	6	7
Weighting	60	35	30	15	20	10	10
Normalizing (%)	33	19	17	8	11	6	6

Source: Adeogun, et al., 2016

HPG: Hydropower generated in period t

C: Cost of hydrological hydropower production loss, measured in 2020 USD

WMD : Hydrological factor in hydropower loss

p: Selling price of electricity for t period, measured in 2020 USD per kWh

Two scenarios were calculated to estimate the generation losses for each hydropower plant. For Andekaleka, the first one used the difference between the installed capacity at a 95 percent efficiency rate and the actual generation, and the second scenario used the difference between the maximum historic generation and actual generation. For the other two dams, Scenario 1 used the difference between capacity at a 90 percent efficiency rate and actual generation, and a second scenario used the difference with the maximum historical generation. The final reported values are the average of the two scenarios. Historical electricity tariffs for the period between 2001 and 2020 were used, considering the distribution of clients between the different zones and the low, medium and high tension differences,[234] each with their respective price tiers.

ii. Potential dredging costs of reservoirs

The impact of land degradation on hydropower plants can also be calculated based on the cost of dredging the accumulated sediments. This methodology is often used for the estimation of land management costs of land degradation, specifically the cost of loss in hydropower production (see for example Udayakumara & Gunawardena, 2017).[235]

The estimation method is described in the following formula:

$$C = S * D \quad \text{(Equation 11)}$$

where

C: Cost of dredging reservoir, measured in 2020 USD

S: Total sediment trapped in reservoirs, measured in tons

D: Cost of dredging, measured in 2020 USD per ton

For the sediment trapped, we used the sediment export result from the SDR model, summed for each dam's contributing watershed area. Total sediment arriving at each dam was adjusted to account for trapping efficiency of the reservoirs, following the approach of Brune (1953)[236] which relates trapping efficiency as a function of reservoir storage capacity and contributing watershed area. Incoming sediment values were adjusted according to the estimated trapping efficiency for each dam as given in the table below, to calculate the actual amount of sediments trapped in each reservoir.

To determine the price of dredging in Madagascar, an extensive literature review was performed. The review showed that prices of dredging range from US$3 per ton to US$9.4 per ton. Annandale et al. (2016)[237] suggests US$3 per ton as a price reference, and in the WEDA report (2021)[238] the range for dredging price over the last decade has been US$3.5 to US$5.8 per m^3. Adeogun et al. (2015) uses a price of US$9.4 per m^3 as the official price according to the National Inland Waterways Authority (NIWA). Grimaldi et al. (2013)[239] uses a price of US$4.5 per ton for Burkina Faso, a country with a similar economy to Madagascar.[240]

234 Office de Régulation de L'électricité Madagascar : Donnés Techniques, Tarifs. (http://www.ore.mg/jargon.html).

235. Udayakumara, E.P., & Gunawardena, U. (2017). Reducing Siltation and Increasing Hydropower Generation from the Rantambe Reservoir, Sri Lanka

236. Brune, Gunnar M. 1953. Trap efficiency of reservoirs. Transactions, American Geophysical Union, 34(3), 407.

237 Annandale, G. W., Morris, G. L.Karki, P. 2016. Extending the life of reservoirs : sustainable sediment management for dams and run-of-river hydropower. Washington, DC: World Bank Group.

238. WEDA. 2021. WEDA's Technical Report: "Reservoir Dredging: A Practical Overview". Available at: Error! Hyperlink reference not valid.

239. Grimaldi, S., Angeluccetti, I., Coviello, V., & Vezza, P. 2013. Cost-Effectiveness of Soil and Water Conservation Measures on the Catchment Sediment Budget-The Laaba Watershed Case Study, Burkina Faso. Land Degradation & Development, 26(7), 737–747. doi:10.1002/ldr.2212

240. Both countries classified by the World Bank as low-income economies and with GDP (international dollars) of 46.08 billion $ in 2019 and 47.53 billion $ in 2020 in Burkina Faso and 42.76 billion $ in 2019 and 45.5 billion $ in 2020 Madagascar.

Table A4.2. Sediment Trapping Efficiency for Dams in Madagascar

Dam	Sediment trapping efficiency %
Ambilivily	0.8725
Amboromalandy	0.5717
Andekaleka	0.8805
Antanifotsy	0.8426
Antelomita *	0.8161
Mandraka	0.8161
Mantasao	0.8977
Sahamoloto	0.7528
Tsiazompaniry	0.8947

*Two dams located upstream of Antelomita (Tsiazompaniry and Mantasao) also act to trap some sediments arriving from the upper watersheds. Therefore, sediment inflows to Antelomita were further adjusted to account for trapping efficiencies of upstream dams, as follows: Antelomita = Sediment trapping efficiency Antelomita x [sediment export Antelomita - (sediment to export to Tsiazompaniry x sediment trapping efficiency Tsiazompaniry) - (sediment export to Mantsoa x sediment trapping efficiency Mantasao)]

Two scenarios were calculated to account for uncertainty in estimating the dredging cost, since specific information for Madagascar was not available: Scenario 1 assumes a unit cost of dredging of US $4.5 per ton, which is the average cost from the literature review; and Scenario 2 assumes a unit cost of dredging of US$9.4 per ton (maximum price from literature review). Final reported values are the average of these two scenarios.

3.3. Agriculture

i. Productivity losses

One of the sectors most affected by land degradation is agriculture, due to the close relationship between soil health and productivity. A number of studies in Madagascar and other countries have proven that erosion, lower water availability and other land degradation indicators have a negative effect on yields. Some relevant papers that shed light on this issue are presented in the table below.

Pimentel et al. (1995), Sartori et al. (2019), and Lal, R. (1995) estimate that high erosion decreases agricultural productivity approximately eight percent in comparison to areas with no erosion. Based on this coefficient, an estimate of the lost value in agricultural production due to land erosion was obtained by incorporating mean erosion at the regional level from the SDR model, prices of main crops, and regional data on agricultural production. The definition of what constitutes high erosion varies by country, with values ranging over a broad spectrum, depending on sources. For the Madagascar case, two scenarios were used to classify regions afflicted by erosion. The first scenario used the average value of 70 tons per ha as the threshold for eroded regions, while the second scenario considered regions with erosion of over 50 tons per ha as impacted. Final reported values were the average of the two scenarios. In the case of regions afflicted by erosion, the estimation of productivity losses was calculated based on the following formula.

$$C = \sum_{}^{n} R_{it} \cdot L \cdot P_{it} \qquad \text{(Equation 12)}$$

where

C: cost of agricultural losses for erosion afflicted region, measured in 2020 USD

R: Total production of crop i in period t, measured in tons

L: Production loss coefficient

P: Price of crop i in period t, measured in 2020 USD per ton of produce

ii. Potential dredging costs of irrigation dams

An additional impact of land degradation in the agricultural sector is the siltation in irrigation dams. Similarly, as in the case of hydropower, removing the sediments accumulated in the reservoirs implies an investment proportional to the severity of the problem. The potential cost of dredging these reservoirs was calculated using the same method described above for hydropower dams. Similarly, two scenarios were calculated, using the average cost of dredging and maximum values obtained from literature review, as described in Section 2.2.2.

Table A4.3. Relevant Citations and Methodology

Citation	Geographic Focus	Main Results	Methods
Carret, J; Loyer, D. (2003). Madagascar protected area network sustainable financing. Economic analysis Perspective.	Madagascar	10% loss of productivity in rice plots, due to silted irrigation channels and suboptimal water availability	Field data analysis in Maroantsetra and Alaotra.
Randrianarisoa, J. & Minten, B. 2001. Agricultural Production, Agricultural Land and Rural Poverty in Madagascar	Madagascar	Cyclones on previous year reduce Agricultural production value on 7% (National Level estimate).	National Survey, statistical analysis, and market prices
Portela, R., Nunes, P. A. L. D., Onofri, L., Villa, F., Shepard, A., & Lange, G. M. (2012). Assessing and valuing ecosystem services in the ankeniheny-zahamena corridor (caz), madagascar. A Demonstration Case Study for the Wealth Accounting and the Valuation o f Ecosystem Services (Waves) Global Partnership.	Madagascar	1% increase in the use of water (rainfall or irrigation) leads to a 0.91% increase in the production of rice and a 0.83% increase in the production of manioc	Production function
Sartori, M., Philippidis, G., Ferrari, E., Borrelli, P., Lugato, E., Montanarella, L., & Panagos, P. (2019). A linkage between the biophysical and the economic: Assessing the global market impacts of soil erosion. Land use policy, 86, 299-312.	Global	Mean crop yields loss in areas of severe erosion of 8% in comparison to non-affected areas	Literature review
Pimentel, D., Harvey, C., Resosudarmo, P., Sinclair, K., Kurz, D., McNair, M., ... & Blair, R. (1995). Environmental and economic costs of soil erosion and conservation benefits. Science, 267(5201), 1117-1123.	Global	Severe soil erosion by water (rates of higher than 17 tha−1 year−1) can cause a crop productivity loss of 8% annually.	Review article
Lal, R. (1995). Erosion-crop productivity relationships for soils of Africa. Soil Science Society of America Journal, 59(3), 661-667.	Africa	Yield reductions due to severe erosion may range from 2% to 40%, with a mean of 8.2% for the continent.	A review of available data in African plots

4. ESTIMATING BENEFITS OF INTEGRATED LANDSCAPE MANAGEMENT (ILM)

Spatially explicit ecosystem services models (as described in Section 1) were applied to estimate the potential improvement that could be achieved through implementing ILM in productive landscapes in Madagascar. The objective of the analysis was to identify the areas where the implementation of ILM practices can have the greatest effect in reducing soil loss, thereby preventing further losses in the productivity of croplands and grasslands, and in improving rainfall-runoff dynamics, thereby reducing peak flows (which exacerbate flood risk) and increasing base flows.

ILM potential was estimated using the same InVEST SDR and SWY models developed for the degradation trends analysis. The models were run for the baseline (2020) condition, and then again applying a scenario that reflects the potential implementation of ILM. The ILM scenario assumed broad investments in activities that improve the condition of vegetation and soil cover, such as agroforestry, silvopasture, revegetation, etc., and assumed that such activities would be focused in areas classified as croplands (cultivated and managed vegetation), grazing areas (grasslands vegetation), or in degraded areas classed as bare ground or shrubland. These land management practices are assumed to be implemented in all available locations in the country, reflecting what the landscape could look like if there was a strong commitment to implementing land management across the board. This approach allowed for highlighting the watersheds where full implementation brings the greatest potential benefits.

Model parameters reflecting the implementation of soil conservation activities and surface runoff management

practices were used as input to the SDR and SWY models. ILM implementation was reflected in the SDR model by assuming a 15 percent improvement in the management factor for shrublands and bare areas, and a 40 percent improvement in croplands and grasslands. In the SWY model, changes were reflected as a 15 percent increase in water use by vegetation (reflecting more vegetation density and/or vigor), a five percent reduction in runoff curve number for shrublands and bare areas, and a 10 percent reduction in runoff curve number for croplands and grasslands (reflecting vegetation's ability to capture and infiltrate rainfall). See Section 6 for model parameters. We assumed 2040 as the time frame for the ILM scenario, reflecting full implementation of improved practices.

The benefits of ILM are estimated as the change in the average annual erosion rate, sedimentation rate to major reservoirs, annual average baseflow, and annual storm surface runoff for each pixel between the baseline (2020) land cover and the scenario where ILM practices are implemented. The catchment areas for major dams were taken from the Global Reservoir and Dam Database (GRanD) v1.3 dataset (Lehner et al., 2011).[241] Changes in erosion were summarized at the regional level to allow for valuation of benefits to crop productivity. Changes in annual sedimentation were summarized for each catchment area of the three major hydropower reservoirs (Andekaleka, Antelomita, and Mandraka) and the six major irrigation reservoirs (Ambilivily, Amboromalandy, Antanifotsy, Mantasao, Sahamoloto, and Tsiazompaniry).

The pixel level results for change in erosion, baseflow, and storm surface runoff from ILM implementation were combined into an index of ILM potential by first calculating the difference between the baseline and the ILM scenarios. For erosion and storm runoff, a greater reduction in the indicator value indicated a greater benefit of ILM. For baseflow, the sign of the change was reversed, to indicate that a greater increase in baseflow is an improvement. The mean of each indicator's difference was calculated at the district level. District level means were then classified based on quartiles (25th percentile, 50th percentile, 75 percentile, and 100 percentile) and assigned a value of one to four. The final index of ILM potential is the sum of the component quantile scores.

Note that for this high-level screening analysis, we do not make any assumptions about the specific land management practices employed; rather, we assume that the most locally appropriate ILM practice will be selected and implemented, and the end result will be an enhancement of vegetation cover, water infiltration, and soil health. Details on the specific ILM practices that are most appropriate and effective for a given location are left for subsequent analyses, when we expect that locally specific data are available, coupled with stakeholder engagement on feasible and locally acceptable practices.

5. VALUING ILM BENEFITS

Restoring environmental integrity can also lead to economic gains. Based on the modeling described in Section 3, it was possible to estimate the potential value of integrated landscape management for Madagascar. We focused on projecting potential gains for the agriculture and hydropower sectors over a 20 year future period.

5.1 Hydropower and irrigation dams

The reduction of sediment exports in the watersheds of dams, achieved by the implementation of ILM practices would result in lower potential dredging costs. The valuation of the amount of total savings was calculated by first estimating the potential dredging costs without the implementation of ILM. For this we used the values calculated for dredging of sediments accumulated during 2020, multiplied it by two dredging costs (US$4.5 and US$9.4 per ton) and used the average of the two costs as the final value. We then assumed that this cost would remain constant until 2040.

Cost of dredging under ILM practices used the new estimates of sediment exports obtained from the ILM scenario, adjusted for the trapping efficiencies of reservoirs, and multiplied by the two possible dredging costs over the 20 year analysis period. The savings from implementing ILM practices for each hydropower and irrigation dam is the difference between the costs in the Business as Usual (BAU) projection and the average of the two ILM projections, as described in the formula below.

241 Lehner, B., C. Reidy Liermann, C. Revenga, C. Vörösmarty, B. Fekete, P. Crouzet, P. Döll, M. Endejan, K. Frenken, J. Magome, C. Nilsson, J.C. Robertson, R. Rodel, N. Sindorf, and D. Wisser. 2011. High-resolution mapping of the world's reservoirs and dams for sustainable river-flow management. Frontiers in Ecology and the Environment 9 (9): 494-502.

$$S = \sum CBAU_t - CILM_t \quad \text{(Equation 13)}$$

where

S: Savings from the implementation of ILM practices, measured in 2020 USD

CBAU: Cost of dredging a dam in period t, in the Business as Usual projection

CILM: Cost of dredging a dam in period t, in the ILM projection

5.2 Agriculture

The reduction in erosion from the implementation of ILM practices will also result in gains for the agricultural sector. The potential benefits that could be achieved were calculated by first estimating the potential productivity losses without the implementation of ILM. For this, we used the values calculated for agricultural losses in the different regions of Madagascar during 2020, from the results of Section 2.3.1. We then assumed that these costs would remain constant until 2040.

To calculate potential agricultural losses under ILM practices, we used the new estimates of erosion obtained from the ILM implementation scenario. These estimates showed the final erosion to be expected by 2040 in the intervened regions. We then assumed that the decrease in erosion would be linear at a constant rate, reflecting a linear establishment and growth of vegetation over the 20 year period. This assumption allowed us to project specific erosion values for each region and for each year between 2020 and 2040. The level of erosion in turn determines if a region would suffer losses from erosion degradation, just as in the case of the BAU projections. Similarly, two different levels of erosion define the threshold for losses, 70 tons per ha and 50 tons per ha, and the final value is the average of the two scenarios.

The gain in agricultural productivity from implementing ILM practices for a specific region in Madagascar is the difference between the productivity in the Business as Usual projection and the average of the two ILM projections, as described in the formula below, while total savings are the sum of all regions.

$$G = \sum AILM_t - ABAU_t \quad \text{(Equation 14)}$$

where

G: Agricultural gains value, measured in 2020 USD

AILM: Agricultural losses due to erosion in ILM projection in period t

ABAU: Agricultural losses due to erosion in BAU projection in period t

6. DATA SOURCES USED IN THE LAND DEGRADATION ANALYSIS

Data type	Description	Date covering data	Resolution	File Format	Source	Source Link	Used For
General							
DEM	Digital Elevation Model	2000	90m	Raster	WWF Hydrosheds, Hydrological Cond. DEM	https://www.hydrosheds.org/	SDR and SWY modelling
Land Cover & Land Use	LULC from ESA Climate Change Initiative (CCI) global land cover (CCI)	1992-2020	300m	Raster	European Space Agency Climate Change Initiative (ESA CCI)	https://cds.climate.copernicus.eu/cdsapp#!/dataset/satellite-land-cover?tab=form	SDR, AWY and SWY modelling
Precipitation	Daily precipitation	1992-2020	5Km	Raster	Global Precipitation Climatology Project (GPCP) Climate Data Record (CDR) Daily analysis	https://data.chc.ucsb.edu/products/CHIRPS-2.0/africa_monthly/tifs/	SWY modelling
Administrative Units	Regions and District boundaries	2018	Admin level 1,2,3,4	shapefile	The Humanitarian Data Exchange	https://data.humdata.org/dataset/madagascar-administrative-level-0-4-boundaries	SDR, AWY and SWY and modelling

Data type	Description	Date covering data	Resolution	File Format	Source	Source Link	Used For
Erosion (SDR)							
Soil erodibility	Soil USLE_K erodibility coefficient derived from physical properties	1950-2020	30m	Raster	Africa Soil Grids	https://www.nature.com/articles/s41598-021-85639-y	SDR modelling
Rainfall erosivity	Annual average rainfall erosivity	2000-2010	1km	Raster	Rainfall Erosivity of the World	https://esdac.jrc.ec.europa.eu/content/global-rainfall-erosivity	SDR modelling
USLE_C	Crop cover factor, by land use/land cover type	1990-2020	300m	Table	USLE_C crop/cover factor, obtained from regional studies and InVEST 3.9 model user guide recommendations	https://doi.org/10.1007/BF00889179	SDR modelling
USLE_P	Management practice factor, by land use/land cover type	1990-2020	300m	Table	Average USLE_P from two recent field based studied in Madagascar	https://biblio.univ-antananarivo.mg/pdfs/rakotomamonjyTolojanaharyE_ESPA_MAST2_16.pdf https://onlinelibrary.wiley.com/doi/10.1002/ldr.3016	SDR modelling
Seasonal Water Yield (SWY)							
Precipitation	Annual and monthly precipitation	Monthly precipitation since 1992 to 2020	5km	Monthly and annually	Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS)	https://data.chc.ucsb.edu/products/CHIRPS-2.0/	AWY and SWY modelling
Evapotranspiration	Reference evapotranspiration (et0)	Estimated from dekadal (10-day) et0 since 1992 to 2020			Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS)	https://data.chc.ucsb.edu/products/Hobbins_RefET/	AWY and SWY modelling
Depth to Bedrock		2021	30m	Raster	Africa Soil Grids	https://www.nature.com/articles/s41598-021-85639-y	AWY
Hydrologic Soil Group	Derived from soil physical properties, following USDA recommendations	2020	250m	Raster	The Oak Ridge National Laboratory	https://daac.ornl.gov/cgi-bin/dsviewer.pl?ds_id=1566	AWY modelling
Kc	Water use coefficient by land cover/land use type	1992-2020		.csv table	InVEST 9.1 user guide Kc calculator and FAO data	https://naturalcapitalproject.stanford.edu/sites/g/files/sbiybj9321/f/kc_calculator.xlsx	AWY modelling

Data type	Description	Date covering data	Resolution	File Format	Source	Source Link	Used For
Climate Zones	Rainfall statistics calculated at District level	2001		Raster		https://www.worldwildlife.org/publications/terrestrial-ecoregions-of-the-world	SWY modelling
Net Primary productivity (NPP)	MOD17A3HGF v006 MODIS/ Terra Net Primary Production Gap-Filled Yearly L4 Global 500 m SIN Grid		500 m	Raster	The United States Geological Survey (USGS)	https://lpdaac.usgs.gov/products/mod17a3hgfv006/	NPP
Vegetation health Condition	Landsat 5,7 and 8 used for calculation of the Normalized vegetation Index (NDVI)	1992-2020	30 m	Raster	The United States Geological Survey (USGS)		NDVI
Socio-economic factors							
Livestock (cattle, sheep, and goat)	Livestock distribution in 2010 expressed in total number of specified animals per pixel. Gridded Livestock of the World database (GLW 3). The dasymetric method (DA) was selected	2010	1 km m	Raster	FAO	https://www.fao.org/livestock-systems/global-distributions/cattle/en/	
Human Population grid	The Gridded Population of the World, Version 4 (GPWv4): Population Density Adjusted to Match 2015 Revision of UN WPP Country Totals	2000, 2005, 2015, 2020	1km	Raster	Center for International Earth Science Information Network - CIESIN - Columbia University. 2018	https://sedac.ciesin.columbia.edu/data/set/gpw-v4-population-density-adjusted-to-2015-unwpp-country-totals-rev11/data-download	
Protected areas boundary	From IUCN The World Database on Protected Areas (WDPA)					https://www.iucn.org/theme/protected-areas/our-work/world-database-protected-areas	

7. INVEST MODEL PARAMETERS

We derived sediment delivery ratio (SDR) model parameters of C and P factors primarily from.36,37 The cover factor C in cropland, we used values based on crop cover effectiveness in reducing soil erosion from Clay and Lewis (1990). We used P factors of 1 for all land cover types except for cropland which is 0.531. The P factor was an average based on field measurements reported in Rakotomamonjy et al. (2016)38 from the Avaratrambolo watershed. A study by the Institut National des Sciences et Techniques Nucleaires (INSTN - Madagascar) team found that traditional terrace systems have an effect of reducing soil erosion by up 40 percent in eastern central highlands.39,40 We applied default values for Borselli IC0 and maximum SDR parameters and set threshold flow accumulation to 1,100 based on evaluation of the model-derived stream networks using various accumulation parameters.37

Table A4.4. Biophysical Table for Sediment Delivery Ratio

LULC_desc	lucode	usle_c	usle_p
Tree Cover	10	0.001	1
Shrubland	20	0.08	1
Grassland	30	0.08	1
Cropland	40	0.17	0.55
Built-up	50	0.1	1
Bare Sparse vegetation	60	0.45	1
Water body	80	0	1
Wetland	90	0.077	1
Mangrove	95	0.001	1

Table A4.5. Biophysical Table for Sediment Delivery Ratio, with ILM Implemented

LULC_desc	lucode	usle_c	usle_p
Tree Cover	10	0.001	1
Shrubland + ILM	20	0.08	0.85
Grassland + ILM	30	0.08	0.6
Cropland + ILM	40	0.17	0.4
Built-up	50	0.1	1
Bare Sparse veg + ILM	60	0.45	0.85
Water body	80	0	1
Wetland	90	0.077	1
Mangrove	95	0.001	1

Table A4.6. Biophysical Table for Seasonal Water Yield Model

Description	lu code	Kc_1	Kc_2	Kc_3	Kc_4	Kc_5	Kc_6	Kc_7	Kc_8	Kc_9	Kc_ 10	Kc_ 11	Kc_ 12	CN_A	CN_B	CN_C	CN_D
Tree Cover	10	0.837	0.891	0.833	0.887	0.881	0.856	0.846	0.813	0.805	0.783	0.798	0.899	30	30	41	48
Shrubland	20	0.664	0.658	0.682	0.844	0.788	0.561	0.402	0.34	0.379	0.411	0.611	0.59	30	30	41	48
Grassland	30	0.688	0.676	0.711	0.835	0.845	0.704	0.585	0.488	0.503	0.545	0.617	0.67	30	30	41	48
Cropland	40	0.683	0.95	1.21	0.95	0.71	0.55	0.55	0.3	0.3	0.3	0.3	0.583	67	78	85	89
Built-up	50	0.2	0.475	0.475	0.45	0.45	0.2	0.2	0.25	0.25	0.25	0.25	0.2	91	91	91	91
Bare/Sparse	60	0.2	0.475	0.475	0.45	0.45	0.2	0.2	0.25	0.25	0.25	0.25	0.2	91	91	91	91
Water body	80	1.03	1.028	1.031	1.099	1.09	1.035	0.972	0.924	0.935	0.954	1.012	1.016	99	99	99	99
Wetland	90	0.73	0.722	0.733	0.886	0.858	0.733	0.579	0.469	0.509	0.549	0.701	0.697	49	69	79	84
Mangrove	95	1	1.2	1.2	1.2	1	1	0.5	0.5	0.5	0.5	0.5	1	49	69	79	84

Table A4.7. Biophysical Table for Seasonal Water Yield Model, with LMP Implemented

Description	lu code	Kc_1	Kc_2	Kc_3	Kc_4	Kc_5	Kc_6	Kc_7	Kc_8	Kc_9	Kc_ 10	Kc_ 11	Kc_ 12	CN_A	CN_B	CN_C	CN_D
Tree Cover	10	0.837	0.891	0.833	0.887	0.881	0.856	0.846	0.813	0.805	0.783	0.798	0.899	30	30	41	48
Shrubland + ILM	20	0.764	0.757	0.784	0.971	0.906	0.645	0.462	0.391	0.436	0.473	0.703	0.679	28.5	28.5	38.9	45.6
Grassland + ILM	30	0.826	0.811	0.853	1.002	1.014	0.845	0.702	0.586	0.604	0.654	0.740	0.804	27	27	36.9	43.2
Cropland + ILM	40	0.820	1.140	1.452	1.140	0.852	0.660	0.660	0.360	0.360	0.360	0.360	0.700	60.3	70.2	76.5	80.1
Built-up	50	0.2	0.475	0.475	0.45	0.45	0.2	0.2	0.25	0.25	0.25	0.25	0.2	91	91	91	91
Bare/Sparse + ILM	60	0.230	0.546	0.546	0.518	0.518	0.230	0.230	0.288	0.288	0.288	0.288	0.230	86.5	86.5	86.5	86.5
Water body	80	1.03	1.028	1.031	1.099	1.09	1.035	0.972	0.924	0.935	0.954	1.012	1.016	99	99	99	99
Wetland	90	0.73	0.722	0.733	0.886	0.858	0.733	0.579	0.469	0.509	0.549	0.701	0.697	49	69	79	84
Mangrove	95	1	1.2	1.2	1.2	1	1	0.5	0.5	0.5	0.5	0.5	1	49	69	79	84

Table A4.8. Climatic Table for Seasonal Water Yield Model

ECO_NAME	cz_id	jan	feb	mar	apr	may	jun	jul	aug	sep	oct	nov	dec
Madagascar dry deciduous forests	2	26	24	21	6	3	4	3	1	1	10	14	22
Madagascar lowland forests	17	23	18	22	16	11	7	6	1	0	9	7	16
Madagascar spiny thickets	11	12	12	10	6	4	5	2	0	6	6	4	12
Madagascar subhumid forests	18	26	20	21	12	8	8	4	1	2	9	12	20
Madagascar succulent woodlands	12	18	16	8	5	5	4	1	0	4	3	7	14

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